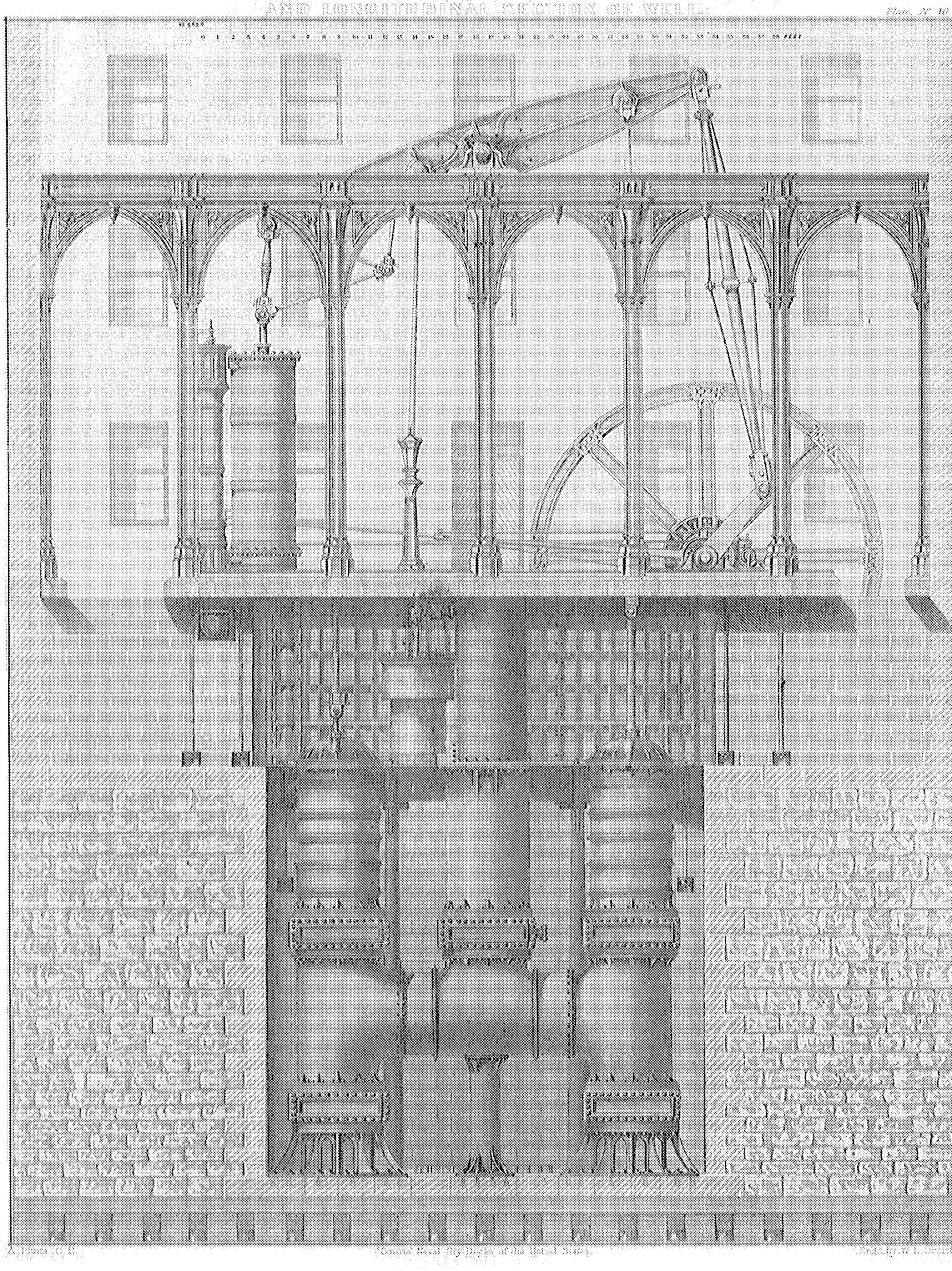
SIDE ELEVATION OF ENGINE & PUMPS, AND LONGITUDINAL SECTION OF WELL.

Plate. Nº. 10.



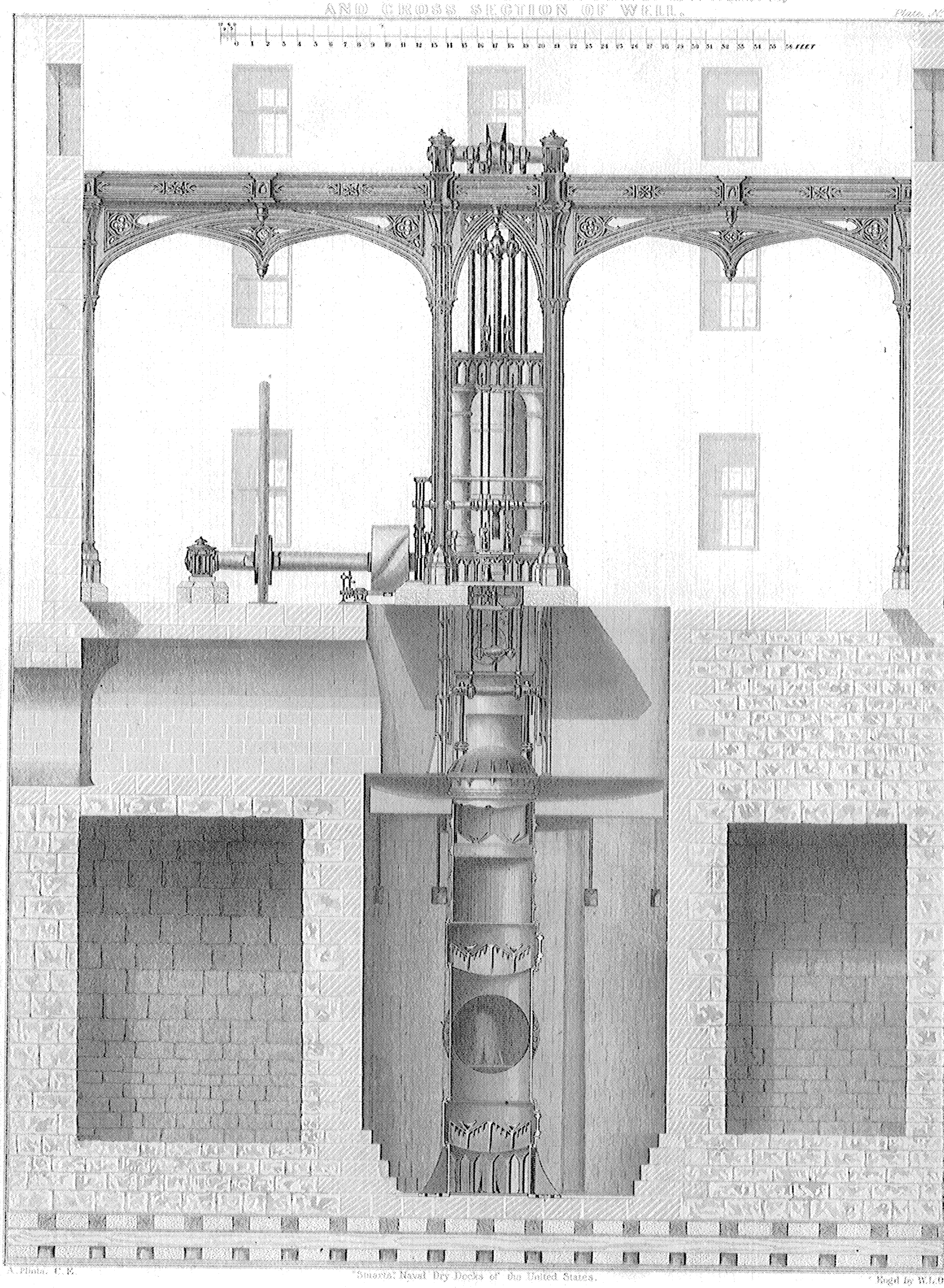
A. Flinta, C. E.

Stuarts Naval Dry Docks of the United States.

Engd by W. L. Ormsby.

FRONT ELEVATION OF ENGINE & PUMPS,
AND CROSS SECTION OF WELL.

Plate No. II.



A. Pinta, C. E.

"Stuart's" Naval Dry Docks of the United States.

Engd by W. L. Ormsby

THE

NAVAL DRY DOCKS

OF THE

UNITED STATES.

BY

CHARLES B. STUART,

ENGINEER-IN-CHIEF OF THE UNITED STATES NAVY.

ILLUSTRATED WITH TWENTY-FOUR FINE ENGRAVINGS ON STEEL.

FOURTH EDITION.

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1870.

THIS VOLUME

IS

Dedicated,

BY PERMISSION,

TO

HIS EXCELLENCY,

MILLARD FILLMORE,

President of the United States,

WITH SENTIMENTS OF GRATEFUL ESTEEM,

BY HIS SINCERE FRIEND,

AND DEVOTED SERVANT,

THE AUTHOR.

PREFACE.

For years past, the achievements of American ingenuity, skill, and industry, have very generally been underrated, or not properly appreciated, both at home and abroad; not because they are inferior to the public works of any other country, in magnitude, or any essential element, that constitutes their usefulness; but, it is believed, because a history or description of them has rarely been sent forth to the world. This has doubtless been owing to the apprehension, that the limited home circulation of an American mechanical work, would not repay the great expense necessarily incurred in its proper production.

Believing, however, that an intelligent and discriminating American public will generously encourage a zealous effort to introduce to its notice several of the most important national works of the country, the author has devoted, during the past year, the very few hours that could properly be spared from daily official duties, to show, in the most practical manner, the mode of constructing and working the Naval Dry Docks of the United States, at the Navy Yards of New York, Philadelphia, Boston, Portsmouth, Norfolk, Pensacola, and San Francisco (costing, not less than Seven Millions of Dollars), and to give a complete history and description, in the fullest detail, of the Granite Dry Dock, New York (the largest in the world), the Floating

Sectional Dry Dock, Philadelphia, and the Floating Balance Dry Dock, Portsmouth, fully illustrated by engravings on steel.

Care has been taken to refer constantly to the official records of the Navy Department, and the reports of the engineers in charge of the several docks during their construction, for valuable and reliable information.

It is believed that this work will be found interesting to the American statesman, and the officers of the Government, particularly those of the Army and Navy; and to the engineers, mechanics, and contractors of the country, the mass of statistical information it contains, including the detailed cost of the particular works described, cannot fail to be eminently useful.

CHARLES B. STUART.

NEW YORK, *April*, 1852.

PART FIRST.

GRANITE DRY DOCKS.

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CONTENTS.

ILLUSTRATIONS.

ENGRAVED BY ORMSBY.

NEW YORK DRY DOCK.

HISTORY.

The site for a Naval Dry Dock, in the harbor of New York, was examined by Colonel Loammi Baldwin, civil engineer, in 1826. This examination proved the feasibility of constructing a stone Dry Dock, of sufficient capacity to receive a ship of the line, and received the approval of Congress.

Nothing further, however, was done until the 3d of March, 1835, when Congress authorized an examination for the definite location of a Dry Dock, at New York, and appropriated one hundred thousand dollars for commencing the work. In the following June, Colonel Baldwin again surveyed the harbor of New York, and reported in favor of locating the Dock within the Navy Yard.

About five thousand dollars of the appropriation was at that time expended, and the balance remained in the Treasury until December, 1837, when it was carried to the surplus fund.

From this period until 1841, although the subject was annually brought before Congress, in the Reports of the Department, owing to the conflicting opinions as to the most eligible site for a Dock, no decisive measures were taken for its construction, until the Act of March 3d, 1841, making appropriations for the Navy, embraced in the items for improvements at New York, the sum of fifty thousand dollars, for commencing a Dry Dock at that Navy Yard.

The work was accordingly commenced, under the direction of Edward H. Courtenay, professor of civil engineering, at the National Academy, West Point, who was appointed chief engineer in August, 1841, and remained in charge until the 1st of August, 1842, when all operations were suspended.

While the work was under the direction of Professor Courtenay, the surveys of the site, preparations of plans, the construction of steam-engine and pumps for the temporary drainage, the driving of about one sixth of the number of piles required for the original Coffer-Dam, and the building of the receiving wharf, were all completed, at a cost of thirty-five thousand, two hundred and sixty-four dollars and twenty-five cents.

By the Act of August, 1842, the sum of one hundred thousand dollars was appropriated for the Dry Dock at New York, with the proviso, that no part of this, or any former appropriation, should be applied to the construction of a Dry Dock until a suitable place shall be selected in the harbor of New York; provided, also, that the Secretary of the Navy may, in his discretion, apply the one hundred thousand dollars now appropriated, and any balance of former appropriations, for the construction of a stone Dry Dock at Brooklyn, or to the construction of a floating Dry Dock at the same place.

Under the first proviso of this Act, a commission, consisting of Captains Connor and Shubrick, of the navy, and Moncure Robinson, Esq., civil engineer, was appointed in August, 1842, by Secretary Upshur, to ascertain if a place more suitable than the original location of the Navy Yard and Dry Dock, could be found in the harbor of New York. Their Report, made in October, of that year, gives the present site preference over all others examined.

In execution of the latter provisions of the Act above referred to, Captain Beverly Kennon, U. S. Navy, Samuel Humphrey, chief naval constructor, and Professor W. R. Johnson, were appointed to proceed to New York, and examine the various plans of floating docks; their advantages and disadvantages as compared with the walled stone dock; and also determine the best plan of a floating dock. They reported in October, 1842, expressing a preference for the walled stone dock over all others, and the balance dock, over the floating docks examined.

By an Act of Congress, of March 3d, 1843, the Secretary of the Navy was directed to cause examinations to be made of the practicability, and probable expense of constructing a Dry Dock at New York, of capacity sufficient to raise a seventy-four-gun ship, using the Croton water as an elevating power; also, to examine other plans of floating or dry docks, deemed worthy to be reported upon, and to suspend all expenditures of previous appropriations for a Dry Dock at New York, until January, 1844.

Secretary Henshaw appointed W. P. S. Sanger, Esq., engineer of the Bureau of Yards and Docks, to make the required examinations under the Act referred to, whose Report, dated January 23d, 1844, disapproves of the plan of using the Croton water, but admits the practicability of constructing a floating dock of the required capacity, and the sectional as the best plan of a floating dock.

NEW YORK NAVY YARD.

By the Act of Congress, of June 17th, 1844, the unexpended balance of the appropriation of August, 1842, was directed to be immediately expended in continuation of the work commenced in 1841, at the New York Navy Yard, or to construct a Dry Dock on some other plan, if the Secretary of the Navy should deem the same best suited for the purposes of the Navy. After a personal examination, Secretary Mason determined that the work upon the stone Dock should be resumed, and for this purpose General William Gibbs McNeil was appointed chief engineer, and the work commenced, 10th of October, 1844, and continued under his charge until April 1st, 1845, when he was succeeded by W. P. S. Sanger, the engineer of the Bureau of Yards and Docks.

During the period the Dock was in charge of General McNeil, the plans for the masonry were enlarged and matured, the Coffer-Dam was extended, and the excavation removed to the level of low tide. The amount expended under his direction, was one hundred and fourteen thousand, six hundred and seventy-one dollars and eighty-three cents.

On the 3d of March, 1845, Congress appropriated one hundred and fifty thousand dollars for this work, of which sum Mr. Sanger expended, from April 1st, 1845, to June 23d, 1846 (when he was succeeded by Wm. J. McAlpine), one hundred and fifteen thousand, nine hundred and fifty-one dollars and eighty-one cents, principally upon the construction of the Coffer-Dam, and dredging the excavation below the water, inside of the Dam, as will be more particularly noted in the description of the Coffer-Dam and earth work.

Mr. McAlpine was succeeded by Gen. Charles B. Stuart, state engineer and surveyor of New York, the 1st of October, 1849, up to which period there had been expended, under the direction of Mr. McAlpine, eleven hundred and fourteen thousand, three hundred and eleven dollars and nine cents, principally for the work of enlarging and completing the Coffer-Dam; the excavating of the bottom portion of the pit excavation; the driving of the foundation piles; the putting in the foundation timbers and concrete; the construction of a large portion of the superstructure of the Dock; and the foundations of the pump-well and engine house.

Gen. Stuart remained in charge of the Dock from the 1st of October, 1849, to the date of its completion, the 30th of August, 1851, during which time the expenditures were seven hundred and thirty-two thousand, nine hundred and seventy-four dollars and sixty-three cents, being mainly expended for cutting and laying thirteen thousand, eight hundred and thirty-seven cubic yards of masonry, of which quantity, one thousand eight hundred and sixty-four cubic yards were laid to complete the masonry of the superstructure of the Dock, the residue being in the engine house above the foundation, the culverts and revetment walls of the Dock; also, for the construction of the iron turning gates, and the various culvert gates, and in the almost entire construction of the pumping-engine and pumps, the floating gate or caisson, the

iron work of the engine house (including the roof), the completion of the Dock apron, and the removal of the Coffer-Dam.

In addition to the appropriations heretofore mentioned, Congress has made the following, viz.: In March, 1847, two hundred and seventy-five thousand dollars; in July, 1848, three hundred and fifty thousand dollars; in March, 1849, four hundred and ninety thousand dollars; in August, 1850, one hundred and eighty thousand dollars for the Dock, thirty thousand dollars for the engine house, and twenty thousand dollars for the removal of the Coffer-Dam; and, in March, 1851, seventy-eight thousand dollars for the engine house and iron gates of the Dock.

As has been stated, the work was commenced in 1841, while the late Hon. A. P. Upshur was Secretary of the Navy. When it was resumed in 1844, Hon. John Y. Mason was the Secretary, in which office he continued until March, 1849, with the exception of an interval of about two years, during which period the Hon. George Bancroft was Secretary.

From March 4, 1849, to July 10, 1850, the Hon. William B. Preston, was Secretary of the Navy.

He was succeeded by the Hon. Wm. A. Graham, under whose administration the Dock was completed, in 1851.

The late Commodore Warrington was Chief of the Bureau of Yards and Docks, until June, 1846, since which date, Commodore Joseph Smith has been Chief of the Bureau, and has contributed largely, by his experience and business qualifications, to the successful completion of this great work.

W. P. S. Sanger, Esq., has been the engineer of the Bureau of Yards and Docks, since he gave up this work, in 1846, and has rendered essential service to the several engineers in charge, at various times, during its construction.

The commandants of the Navy Yard, at New York, from 1841 to 1851, have been Captains M. C. Perry, Silas H. Stringham, Isaac McKeever, and W. D. Salter.

The members of Congress from New York city and Brooklyn, have always taken a lively interest in the progress of this work, but none have rendered it more efficient service than Hon. Henry C. Murphy, and Hon. David A. Bokee, late members from King's county.

In concluding this brief history of the commencement, progress, and completion of this Dock, it may truly be said, that no similar work of equal extent, and presenting so many difficulties, has been constructed in America, and but few, if any, in the world.

Its successful completion is as much to be attributed to the untiring industry, skill, and watchfulness of the superintending engineers, and their able assistants, as to the admirable plans and principles upon which it is built, and will remain for ages, one of the proudest monuments of the engineering, and mechanical skill, of the NINETEENTH CENTURY.

DESCRIPTION.

LOCATION OF THE DRY DOCK.

THE New York Navy Yard, established in 1794, occupies the south side of the Wallabout Bay (an arm of the East River), between the cities of Brooklyn and Williamsburgh, on Long Island, opposite the City of New York.

Near the north-east corner of this yard the Naval Dry Dock is located, its front or entrance being built on the edge of the convex channel of the Bay, very near the site selected by Col. Baldwin in 1835.

CHARACTER OF THE SOIL.

The soil of this portion of Long Island is mostly a diluvial formation, composed of a coarse, sharp, red and yellow sand and gravel, interspersed with boulders of trap and greenstone rock, many of which are of very large size.

The site selected for the Dock is, however, of more recent formation. The superstratum was found to be chiefly formed by vegetable decomposition to the depth of ten feet; below this is an almost impalpable quicksand containing a large proportion of mica. When confined and not mixed with water, it is very firm and unyielding, and presents a strong resistance to penetration, but when saturated with water, it becomes semi-fluid, and is moved by the slightest

current of water passing over or through it. Small veins of coarse sand were also occasionally encountered, through which flowed springs of *fresh* water.

At the time when Col. Baldwin examined the site, he extended the borings in several places to a depth exceeding eighty feet, and brought up sand and clay, and also fresh water, but touched no rock. In his Report of 1835, he remarks, that "upon careful examination of these circumstances, I have no doubt a Dry Dock may be safely founded at Wallabout Bay. Should piling for the foundation be necessary, which can best be determined in the process of excavating, the piles cannot be driven deep in such soil, and will have similar or better resisting material than those hitherto used. The construction of a Dock in this yard, however, will be more difficult than either of those built before (at Norfolk and Charlestown)."

In 1842, Professor Courtenay commenced the Coffer-Dam, and states, in his Report of that year, that "during the progress of the work we were enabled to form a very satisfactory opinion as to the *character of the soil* upon which the Dock was to have been founded; and the frequent examinations then made resulted in the conviction, not only, that the substratum was sufficiently firm to resist without danger the pressure arising from the weight of the contemplated structure, but that the nature of the soil was far better adapted, than had been supposed, to resist the percolation of water through the Dam."

Mr. McAlpine, in 1849, reports, that "a deposit of clay, mixed with a large proportion of very fine sand, which covered the north-east portion of the pit for several feet in depth, probably led to the favorable conclusions of these gentlemen. The soil, as it was developed by the excavations, is, as has been previously described, and there is but a very small portion of clay in any part of it. The borings which were made during the progress of the work extended to a depth of *forty* feet below the foundations of the Dock. Specimens have been preserved of the soil taken from the various parts of the foundations, and at every change in depth, including that which was brought up by the borings. Sets of these specimens have been deposited in various public institutions throughout the country."

THE COFFER-DAM.

The foundation required for the superstructure of the Dry Dock, having to be placed thirty-seven feet below mean tide, on the material described above, it became necessary to erect a strong and tight barrier to resist the great pressure and percolations of tide water.

The original plan of the Coffer-Dam designed by Professor Courtenay was composed of three

rows of contiguous yellow-pine piles, fifteen inches square, and from thirty-five to forty feet in length, driven entirely around the lower end or front of the proposed excavation, leaving two intervals of ten and twelve feet between them, which spaces were filled with soil taken from the excavation of the pit, the piles having first been secured at the top and level of low water by horizontal wales of oak, twelve inches square, firmly bolted and tied once in ten feet with iron tie-bolts two inches in diameter. A portion of the piles were tongued and grooved, to prevent the tides from washing out the earth-filling of the Dam, but the difficulty experienced in driving them, from their swerving aside and fracturing or drawing out the tongues, soon led to the relinquishment of the plan.

The dimensions of the Coffer-Dam, as constructed, were four hundred and seventy feet long, and from sixty to one hundred feet wide; the wings were one hundred and seventy-five feet long, and from fifteen to thirty feet wide.

The original Dam was commenced by Professor Courtenay, in 1842, and some progress made in driving piles previous to August of that year, at which time the work was suspended, and not resumed until the 5th of November, 1844. At this period the steam pile-driver was first put in operation, being placed upon a scow or float, but after a short time it was deemed most convenient to place it on a stationary platform upon that part of the Dam which was first driven, when the work progressed successfully during the winter of 1844–5 upon the original plan, and under the direction of General Wm. G. McNeil.

On the 1st of April following, W. P. S. Sanger, Esq., took charge of the work as engineer, and shortly thereafter determined to purchase *green* timber for the remainder of the Dam, as it was found that the *seasoned* yellow pine previously used for piles, in consequence of its quality and the hardness of the bottom, was split and shattered badly in driving.

At this time the small steam-engine erected, being designed for working but one pile-driver, was found incapable of performing as much work as desirable, and early in June, 1845, arrangements were made for applying the power of the large engine to this branch of the work. Two lines of shafting were accordingly procured, with the necessary fixtures, and put up. This proved a valuable acquisition, as it performed a very large amount of work, with comparatively small expense, driving six piling machines, together with the pumps used for the temporary drainage of the Coffer-Dam. "The advantages gained by applying steam in the pile-driving department," remarks Mr. Sanger, in his Report of October, 1845, "will readily be seen by an examination of the following Table (see Appendix, Note A), made from the Register Report of the Master Pile-Driver."

The work upon the Coffer-Dam progressed under the direction of Mr. Sanger until its completion on the original plan, the 1st of February, 1846, when nearly all the puddling had

been put in, and about thirty thousand cubic yards of excavation had been taken out of the pit, by wheelbarrows and dredging.

On the first attempt to remove the water from the pit, it became evident that the Coffer-Dam had not been constructed sufficiently firm to resist the pressure, to which it was subjected. The first yielding occurred on the 2d of February, when about six feet of water had been pumped out of the pit. Nearly the whole length of the north-west wing was forced in at the top, from eight to twenty-four inches, and subsequently yielded as much more. A few days afterward, a portion of the front of the Dam was forced outwards, breaking several of the iron tie-bolts, and as the water was drawn down in the pit, nearly every part of the Dam yielded more or less. These indications of weakness, led to the determination of driving an additional row of piles entirely around the Dam, in the inside, which should penetrate to a greater depth than those previously driven, and from which the original Dam could be braced.

This work was commenced under the direction of Wm. J. McAlpine, Esq., engineer, on the 25th of February, 1846, opposite those portions of the Dam which appeared to be the weakest, and was continued until the 3d of July of that year, at which time it had been extended around the whole Dam, except for about one half of the length of the south-east wing. The space inclosed by these piles was filled as rapidly as they were driven, and braces were extended to the top of the original Dam.

On the 3d of July a breach occurred, without warning, after the workmen had left, in the Coffer-Dam, at the north-east angle and wing, under Engine House, No. 2. The particulars of this breach are given in Appendix, Note B. Several piles driven in the Dam, where the breach occurred, were drawn up, and found to be from thirty-three to thirty-seven feet long. The excavation which had been made in the pit, indicated that this length of pile was not sufficient to penetrate the firm substratum below the silt, deep enough, to prevent the passage of water under the piles, as at the time of the breach it passed under the piles in the original Dam, and burst up before it reached the inside row of longer piles, which had been added to the original Dam.

The breach was repaired by driving a row of piles (generally about fifty feet in length), along the face of the original Dam, and another row of the same length, at thirty feet from the original Dam, for a distance of two hundred feet. The old Dam was refilled with clay and gravel, in equal proportions, and the new Dam chiefly with coarse, heavy gravel. The band of gravel on the inside of the Dam, was replaced and enlarged. A very small amount of leakage passed through that portion of the Dam after it was thus replaced. The repairs were wholly completed on the 25th of August, at a cost of about fourteen thousand, two hundred and fifty dollars, and the excavation inside of the Coffer-Dam resumed.

On the 17th of September following, another breach occurred, at the north-west angle and wing of the Coffer-Dam, the particulars of which are given in Appendix, Note C.

The first indication of this breach was an increased flow of water in one of the bottom springs, which was situated fifty feet from the nearest part of the Coffer-Dam. The water flowing from this spring had previously been fresh; it was on that day observed to change alternately from fresh to salt several times within a few minutes, and in less than an hour had increased to five times its former quantity, and soon after brought up volumes of the black mud which overlays the quicksands in the bottom of the Bay. The direction of this breach was soon developed by the sinking of the Coffer-Dam, some of the piles of which, settled down vertically from five to six feet. The inadequate length of the piles first driven, and an improper connection with the old cob-wharf, were probably the causes which produced this breach.

The repairs were made by driving a row of piles outside of the original Dam, for a distance of about two hundred and thirty feet, from fifty to sixty-two feet in length, the shorter piles being driven to the level of low water. A portion of the old cob-dock was removed, and a row of piles with a tight gravel filling, extended through it to the firm ground in the rear of the dock. The new Dam was filled with coarse, heavy gravel, so that the weight of the earth, would break down into any passage which the water might form through the loose soil on which the Dam rests. In the original Dam it was found that the silt adhered to the timber on the sides, and that the cavities formed by the percolation of the water, became very large before any of the earth broke down to fill them. To prevent this in the new Dam, coarse gravel was discharged in large quantities from boats with drop-bottoms, which contained one hundred tons each. A heavy bank of coarse gravel, was also filled on the inside of the Dam, extending up to the line of the foundation. This breach was repaired in November, at a cost about equal to that of July.

The material on which the Dam rested, was so unstable, that although the piles penetrated it from fifteen to twenty-five feet, below the foundations of the Dock, yet the Dam at times continued to yield to the immense pressure of the water, and was only sustained by the closest watchfulness, and the most prompt application of skilful remedies. As long as the excavation was in progress, there was no opportunity to obtain any support from the inside, and whenever it could be done, chain cables were attached to the Dam and secured to mooring blocks on the shore. These cables, made of iron two inches in diameter, were repeatedly broken. On one occasion six of them broke in a single night. The removal of the excavation adjoining the Dam, was not effected any faster than it could be followed up by the foundation piling, and this was done in trenches, leaving abutments of earth on each side.

Timber shores were extended from the foundation piles to the Dam, before the intermediate sections of earth were removed. In like manner, the rear-work of the masonry on the foun dation, was at first laid in sections, and braces extended from it to secure the Dam. The thrust upon these braces was at one time so great, that it moved a mass of masonry exceeding two hundred and fifty tons in weight.

The earth in the Dam, was at first subject to a continued waste on the side adjoining the Bay, by the action of the water flowing through the joints of the piles; but this abrasion continued to decrease daily, until it became of but little importance.

A double row of sheet piling, was extended entirely around that portion of the pit which was not protected by the Coffer-Dam.

The total number of piles driven in the Coffer-Dam was three thousand five hundred and four, averaging thirty-nine feet in length, and fifteen inches square.

The total cost of the Dam and sheet piling, including repairs of breaches, has been two hundred and forty-five thousand, nine hundred and sixty-nine dollars and twenty-two cents.

THE EARTH WORK.

The pit which was excavated for the Foundation of the Dock, covered an area of two acres at the top, and over one acre at the bottom. It was sunk to the depth of forty-two feet in the earth, thirty-seven feet of which, was below mean high water, requiring the removal of one hundred and twelve thousand cubic yards of earth.

That part of the earth which was above the level of low water, was taken out before the Coffer-Dam was constructed; there was also about ten feet in depth dredged. The semi-fluid state in which the material was found after the water had been pumped out of the pit, rendered its removal very difficult and expensive. When the excavation was commenced in April, 1846, the silt before described, was in so fluid a state, as to require tight vessels to remove it. It was at first taken out in tubs suspended from the arm of a derrick, and hoisted to the requisite level by steam power. This plan was successful, but found tedious, and another method was resorted to.

Several inclined planes were laid down, radiating from a common centre on the top of the Coffer-Dam. Cars with tight bodies, containing about forty cubic feet, were placed upon the planes, and hauled up from the pit to the level of the top of the Dam, by steam power; one rope working three planes. The cars were discharged into lighters with drop-

bottoms, in which the material was conveyed to, and deposited within, the inclosure of the new cob-dock on the opposite side of the channel. This plan was found to be very expeditious, and was continued with success, until interrupted by the breach in July of that year. The cost, however, of transporting the material in the lighters, was found to be greater than to convey it to a Timber Basin, within the Navy Yard, which required filling. A cheap wooden railroad was constructed, on which the cars were moved by horses. The economy and usefulness of these planes and railroads having been satisfactorily shown, six planes and three lines of railroads were laid down, two of the railroads being also arranged, so as to transport the granite from the wharf to the deposit grounds.

Puddle walls were extended from the sides of the masonry, to cut off the passage of water along the walls.

The total cost of the excavation of the pit, was one hundred and forty-one thousand, four hundred and twenty-five dollars and forty-nine cents, exclusive of temporary drainage.

THE BOTTOM SPRINGS.

When the excavation had been extended to within about six feet of the required level for the foundations, springs of *fresh* water burst up, and were the cause of the greatest difficulty encountered in laying down the foundations. The stratum through which the springs flowed, was evidently at a great depth (not less than thirty feet below the foundation); and the veins of water, even those contiguous to each other, were not connected together. The water which flowed from them was entirely fresh, and doubtless came from a source higher than the tide water. Their temperature was 53° F. in January, and 55° in August. The temperature of the water in the Bay, at the same times, was 43° and 46°; and that of the atmosphere, 40° and 90°: the flow was not affected by the rise and fall of the tides.

The largest spring discharged, in 1846, ten gallons per minute. When the water was allowed to flow at a level, twenty-six feet below low water, it discharged thirty-eight gallons per minute, which contained twenty-seven ounces of fine sand; at a level twenty-two feet below low water, it discharged thirty-three gallons, containing seventeen ounces of sand; and at a level seventeen feet below low tide, there flowed ten gallons per minute, unmixed with sand.

These springs presented some peculiar features, and have proved so troublesome, that a particular description of one, and the method adopted to overcome it, will serve to show the

character of the whole, and the difficulties they opposed to laying down the foundations of the Dock. These difficulties did not proceed from the mere flowing of the water, but this, as it came up, brought with it large quantities of sand, so fine and impalpable, as to insinuate itself through the smallest interstices, even through the checks and cracks of the timbers, and if allowed to flow in this way, would soon have endangered the surrounding works: nor could the water be checked with safety, as its pressure was found sufficient to raise the foundation, however heavily it could be loaded. It became necessary, therefore, to provide for the flow of the water, and at the same time check the escape of the sand.

One of the most powerful springs, was encountered near the temporary pump-well, at the north-east corner of the Dock. The first evidence of undermining from this spring, was the settling of the piles driven to support the pumps and engine, rendering it necessary to change the pump-well; but the spring followed, and compelled another change of the well. This spring was driven out of the old well by filling it with piles, but it immediately burst up among the foundation piles of the Dock near by. In a single day it made a cavity in which a pole was run down, to the depth of twenty feet below the foundation timbers. One hundred and fifty cubic feet of cobble stone were thrown into this hole, which settled ten feet during the night, and fifty cubic feet were thrown in the following day, which drove the spring to another place, where it undermined and burst up through a bed of concrete two feet thick. This new cavity was repeatedly filled with concrete, leaving a tube for the water to flow through; but in a few days it burst up through a heavy body of concrete, in a place fourteen feet distant, where it soon undermined the concrete, and even the foundation piles, so that they settled from one to three inches. These piles were thirty-three feet long, and driven by a hammer weighing two thousand, two hundred pounds, falling thirty-five feet at the last blow, with an average of seventy-six blows to each pile, the last one of which, did not move the pile over half an inch.

This alarming result rendered paramount the adoption of the most thorough measures, to prevent any further injuries from this source. It was accordingly determined, to drive as many additional piles as could be forced into the space, and by means of followers, to force those already driven as deep as possible. This work done, although under very disadvantageous circumstances, the old concrete was removed to a depth of twenty inches below the top of the piles; an area of about one thousand square feet around the spring, was then planked, on which a floor of brick was laid in dry cement, and on that, another layer of brick was set in mortar, made of Roman cement; the space was next filled with concrete, and the foundations completed over all, in the usual manner, and with the greatest dispatch possible. Several vent-holes were left through the floor and foundations. After a few days' interval, when the cement had become

well set, the spring was forced up to a level of about ten feet above the former outlet, and at this point it flowed clear, and no longer charged with sand.

The other bottom springs, forty in number, were, many of them, of a like obstinate character; but the successful and gratifying result, obtained with the treatment of that above described, led to the adoption of the same plan with similar success, whenever they caused any great difficulty. Two of these springs were accidentally closed by freezing, in 1848, and forced up, in one case, eight hundred, and in the other, twelve hundred square feet of the foundations. This took place between the lower timbers and the planking, lifting also the first course of the stone floor, which was from twelve to fifteen inches thick. None of the springs were closed until the inverted arches of masonry had been laid, and the cement had become well set. The pressure on the bottom of the floor was then so great, that the water came through the joints, but did not disturb the stone. The arrangement proposed to be accomplished was, to bring up all the springs through the foundation in lead pipes, and have no pressure upon it, until the masonry was laid, and the cement had become well set; but there were many minute veins of water, unnoticed when the foundation was laid, which exerted a force upon the cement joints, rendering their setting very slow, and making it necessary to caulk them carefully, with Roman cement and fine Rockaway sand, in 1850 and '51.

The whole amount of water which flowed into the pit, the last two years of the work, was from these springs, none having leaked through the Dam. The quantity averaged nearly seven hundred cubic feet per hour, which was removed from the pit by a steam-engine of twenty-five horse power, driving two plunger pumps of fifteen inches diameter, and five feet stroke, capable of discharging about six hundred cubic feet of water per minute.

The cost of the temporary drainage was sixty-seven thousand, eight hundred and eighty-four dollars and twenty cents.

THE BEARING PILES.

The whole number of bearing piles in the foundation is six thousand, five hundred and thirty-nine, besides one thousand, seven hundred and forty-four sheet piles, which serve also as bearing piles. The piles are chiefly, round spruce timber, from twenty-five to forty feet long, averaging fourteen inches in diameter at the head. The average length of the piles, as driven, was thirty-two feet seven inches. The sheet piles were yellow-pine plank, five inches thick, and from twelve to twenty-five feet long, averaging fifteen and one-quarter feet: they were tongued and grooved, and driven entirely around the foundation, with four rows across the pit.

It was originally supposed, that piles driven at a distance of three feet, from centre to centre, and twenty to twenty-five feet long, would afford a sufficient foundation to the superstructure; but from the fear that changes might take place, after the foundation was put down, it was determined to drive as many piles as could be forced into the earth. The chief part of the piles were driven to the point of absolute resistance, and whenever a hammer of two thousand pounds weight, falling thirty-five feet, drove the pile for the last few blows, exceeding three inches per blow, another and larger pile was driven alongside. They were protected at the head, by a band of wrought iron, one inch by three, made of the toughest iron that could be procured: one band would usually last to drive two piles before it would burst, and by welding, it could be used for three or four piles.

With the exception of five hundred and forty-one, hereafter mentioned, all these piles were driven by hammers weighing from two thousand to forty-five hundred pounds each, falling from thirty to forty feet. The average number of blows given to the piles, by the small hammers, was one hundred and fifty-one, and by the heavy hammers only fifty blows, the average of all the piles being seventy-three blows to each pile.

The use of the heavy hammers was attended with marked success; the amount of work performed by the machines to which they belonged, was at least one third greater, than that done by those whose hammers were only one half the weight.

A contract was made, with the agent of Nasmyth's steam-piler, to drive thirty-six hundred foundation piles, the machine to commence operations on the 1st of January, 1848, and to drive fifty piles a day, at a price fifteen per cent. less, than similar work was done by the Government. Considerable delay having occurred in obtaining the machine from England, it was not set to work until the month of May. Between that period and the 1st of the following August, it drove five hundred and forty-one piles.

The novel principle on which this machine worked, consisting in very rapid short blows, with a heavy hammer, of four thousand five hundred pounds, hoisted by the stroke of the engine, with each revolution, made its success a subject of general interest.

It could not, however, be fully tested, in consequence of the weak construction of many of its parts, which were not adapted to such hard driving as was encountered on this work. During the three months it was on the work, it was never in sufficient repair to perform one day's full service.

The hammers were hoisted by men working with a crank, and on tread-wheels, and with horses, but chiefly by steam power. The expense of these several methods of driving piles, are in the order in which they have been named.

Great care was taken in registering the performance of all the machines used in con-

structing the foundations of the Dock. The number of blows given to each pile, and the depth driven by every blow, was recorded.

A trial-pile was driven in June, 1846, to the depth of forty-five feet below the foundation. It was a round stick of spruce, twenty inches in diameter at the butt, fourteen inches at the other end, and forty-nine feet long. It was shod with iron, and driven by a hammer weighing two thousand and twenty-four pounds, falling from its greatest elevation thirty-five feet.

For the first hundred blows, the hammer fell but a few inches; the next two hundred and sixty blows, drove the pile thirty inches in forty-six minutes; the next two hundred and sixty-five blows, occupied an hour, and drove the pile from half an inch to one and a half inches, at each blow; the next one hundred and ten blows in an hour, averaged one and a quarter inches at each blow, the hammer falling at the last blow thirty-four feet. The pile subsequently received about two hundred blows through the medium of a follower, which drove it an average of half an inch to each blow.

In June, 1847, a pile was driven forty-three feet by Nasmyth's steam pile-driver; and then another pile fifteen feet long, driven on top of the first, making a total depth driven into the earth of about fifty-seven feet.

The first pile was driven forty-two feet, by three hundred and seventy-three blows in seven minutes, as follows:—four blows, four inches each; eight blows, three and a half inches each; twenty-two blows, three inches each; twenty-five blows, two inches each; forty blows, one and three-quarters inches each; fifty-six blows, one and a half inches each; thirty-two blows, one and a quarter inches each; sixty-four blows, one and an eighth inches each; seventy-three blows, one inch each; the last forty-nine blows, half an inch each blow.

The second pile was driven fifteen feet, by two thousand, four hundred blows, in forty-three minutes, as follows:—thirty-three blows, three eighths of an inch at each blow; seventy-three blows, one fourth of an inch, each; one hundred blows, one eighth of an inch each; eight hundred blows drove it together eighty-eight inches; three hundred blows, twenty-four inches; three hundred blows, twelve inches; four hundred and fifty blows, eleven inches; and the last three hundred and forty blows, together drove the pile five and a half inches.

The movement of these piles indicated the continuance of the same material to the depth which they reached; and the uniformly increasing resistance, as the pile penetrated the earth, gives very favorable evidence of the support which the piles afford, when they are thus driven to the point of absolute resistance. The soil required very hard driving to force the pile into it, and so long as the material was undisturbed, the subsidence of the sand around it, added greatly to the firmness of the foundation. Yet the springs were liable to disturb and loosen the soil around the piles, and, as has been previously stated, destroy their value as supports.

THE FOUNDATION.

It will be obvious, that, from the nature of the material found in the pit, and the troublesome character of the bottom springs, the putting down the foundation was attended with considerable difficulty. To obviate this as much as possible, it was deemed to be the wisest course, by the Engineer (Mr. McAlpine), to follow the excavation between the piles with the immediate laying of the concrete masonry, and then to prosecute the work without interruption, until the section in hand was completed. This involved, in many instances, the necessity of working over-time, and through the night. But in the critical condition of the undertaking, it was impossible to avoid this, without hazarding the loss of whatever might have been left incomplete, and the serious derangement and injury of much that had already been finished.

The foundation has been mostly laid in the following manner:—The excavation having been completed to the proper depth, and the piles levelled, concrete masonry, two feet deep, was laid between the bearing piles, which were then capped with yellow-pine timber, twelve by fourteen inches square, laid transversely with the axis of the Dock, and treenailed to each pile.

The concrete then having been raised to a level with the top of these timbers, a light flooring of yellow-pine plank, three inches thick, was laid upon and spiked to them. Another course of similar timber was then placed upon this floor, breaking joints with those below, to which they were treenailed; the intervals were next filled with concrete masonry, and another floor of plank like the first, was spiked down and completed the foundation.

To cut off the passage of water beneath, the sides of the foundation have been surrounded with sheet-plank piling, and six rows of the same have been driven across the pit.

The concrete masonry above spoken of, was composed of the following ingredients:—One part of hydraulic cement; two parts of coarse, clean sand; three and a half parts of broken stone, not exceeding one and a half inches in diameter, and two and a half parts of beach pebbles, of about the same size.

A mortar was first made of the cement and sand, into which the broken stone was thrown and well mixed, and the pebbles finally added; as soon as the mass was thoroughly incorporated, it was laid into its place in the work, when it commenced to set immediately, and soon became very solid and firm.

The *first* foundation pile was driven on the 26th of January, 1847, and the *last* bearing pile was driven on the 11th of May, 1848: it was thirty-four feet long, and required one hundred and fifty-three blows from a hammer weighing twenty-two hundred pounds.

The whole number of piles which have been driven for the foundation, is six thousand, five hundred and thirty-nine, averaging thirty-two feet seven inches long, and about fourteen inches in diameter; besides which, there have been seventeen hundred and forty-four sheet piles, averaging fifteen feet three inches long, and five by ten inches, tongued and grooved, driven contiguous, entirely around the outside of the foundation; and also intermediate rows across the pit.

The timber foundation required thirty-eight thousand, five hundred and thirty-two cubic feet of yellow-pine timber, twelve by fourteen inches; and two hundred and sixty-nine thousand, one hundred and six feet, B. M., of three-inch yellow-pine plank. The whole amount of concrete masonry put in the foundation, is five thousand, three hundred and forty cubic yards.

The cost of the foundation complete, was one hundred and fifty-three thousand, six hundred and seventy-four dollars and thirty-six cents.

APRON OF DOCK

To protect the front of the Dock from undermining, an apron was extended to the line of the third row of Coffer-Dam piles, a distance of forty-five feet into the channel of the Bay.

In addition to the cutting off the two inner rows of Coffer-Dam piles, to rest the apron upon, four hundred and thirty-eight piles were driven, at suitable distances apart, their heads covered with bevel-hewed timber, secured to them by treenails; the space around the piles for two feet depth filled with concrete, and dovetailed stone blocks, placed between the ranges of timber to secure them from floating, and then the whole covered, with a three-inch plank floor, firmly fastened to the timbers.

This work was done in September, October, and November, 1849, and was attended with much difficulty, consequent upon the springs forcing out quicksand from below the foundations of the Dock, but by constant night and day labor, it was successfully completed, at a cost of three thousand, four hundred and eighty-three dollars and ninety cents.

MASONRY OF THE DOCK.

There is, perhaps no modern structure, that compares with this national work, in the dimensions, or the durability of the materials of which it is composed; or the beauty and accuracy of their workmanship.

Some idea may be formed of its magnitude, from the Plan, represented in Plate One, of the Engravings, and the following statement of its vast dimensions. Eighty thousand tons of stone have been used in forming the foundation, superstructure, and appurtenances of the Dock. The masonry foundations are four hundred feet in length, and one hundred and twenty feet in breadth. The main chamber is two hundred and eighty-six feet long, and thirty feet broad on the bottom; three hundred and seven feet long, and ninety-eight feet broad at the top, within the folding gates. By using the Caisson, or Floating Gate, an additional length of fifty-two feet may be obtained; thus making the entire length of the Dock Chamber, three hundred and fifty feet, on the line of mean high tide. The least width is at the hollow quoins, at which point, the Dock is sixty-eight feet wide; and the least depth is over the mitre sills, which are twenty-six feet below high tide. The height of the wall is thirty-six feet.

These dimensions will allow the docking of a ship of the line within the main chamber, and of the largest war steamers afloat, by using the Floating Gate.

The granite used for the exterior of the masonry, was from the Sullivan and Frankfort quarries in the State of Maine, and the Millstone Point quarries in the State of Connecticut; and the interior stone was chiefly procured from the Staten Island and Highland quarries in the State of New York.

Portions of the stone were dressed at the granite quarries, ready to put into the work, but most of the face-stone were cut at the New York Navy Yard, after their delivery.

The flooring of the Dock is an inverted arch, formed of stone, from four to six feet in depth. This form was given it, to prevent the pressure of the water from below, lifting the floors. That of the main chamber is first formed of a tapering course of cut stone, twenty-seven inches thick at the head, and twelve inches near the mitre sill. The second course of stone is uniformly three feet thick, and the arches are extended nine feet above the floor, on each side. The floor of the other parts of the Dock is made in a similar manner.

The floor of the main chamber is level on the bottom (with the exception of a small drain in the centre), for thirty feet wide; the sides are carried up in altars, for the convenience of shoring the vessels, and working under their bottoms, as shown in Plate Two, Figure Six, where the "PENNSYLVANIA," the largest ship of the line, in the service, is seen.

The side walls are laid up with English bond, viz., alternate courses of headers and stretchers.

The stones in the alternate courses are of the same length, which gives a plumb bond, although the stone in the same course differ in length, a variety of length having been determined upon to facilitate the quarrying of the stone. These lengths have, however, been so arranged, as that adjoining stones do not differ to exceed three inches, and increase and diminish

gradually from the shortest to the longest stone. The difference in length is therefore imperceptible, as seen in Plate Two, Figure One.

The courses are chiefly twenty-four inches thick, a few only, near the bottom, being twenty-seven inches. The beds of the stone in the stretcher courses are from three to four feet broad, and in the header courses from four to five feet deep. The length of the stretchers is from six to eight feet, and of the headers from three to four feet. The headers are in all cases one half the length of the stretchers.

The facing stones were backed up with a course of scabbled stone, cut to the same thickness, and laid to joints not exceeding half an inch.

The interior, and rear of the walls, were laid up with coursed rubble, which has been so selected, that either one or two courses made up the thickness of the facing stone.

The facing stones are all laid to a joint, not exceeding three sixteenths of an inch, and the joints are kept up full to the line, for the full depth of the stone.

The smallest face stone, exceeds three thousand pounds, and the average is about six thousand pounds. Many of the coping, and other large stone, exceed fifteen thousand pounds. The interior stones are also large, and will average upwards of fifteen hundred pounds.

The mitre sills are very massive granite blocks, procured from the Millstone Point quarry, near New London, Connecticut. The keystone is estimated to have weighed about *fifty tons* before it was cut: its weight when placed in the Dock, was forty-three thousand three hundred pounds; and cost five hundred dollars. Sixteen similar stones form the mitre sill, the smallest weighing over thirteen thousand pounds, and the whole costing nearly five thousand dollars. These immense stones were all cut with such accuracy, at the quarry, that they did not require a tool to be put upon them, to fit them to the work.

The weight of a cubic foot of the several kinds of granite, sienite, and gneiss, used on this work, is as follows:—Sullivan, Frankfort, and Seal Harbor, one hundred and sixty-eight pounds; Blue Hill, one hundred and sixty-five; Quincy and Breakneck, one hundred and sixty-nine; Millstone Point, one hundred and seventy; Staten Island one hundred and eighty-six; and Kip's Bay, one hundred and seventy-two pounds.

Nearly twenty-five thousand cubic yards of masonry have been constructed, to form the walls of the Dock. The whole was laid in mortar, made of one part of Hydraulic cement (from the celebrated "Lawrence and Newark" manufactories, at Rosendale, New York), and two parts of clean, sharp sand.

The cement was required to be fresh ground, very fine and lively, and transported under cover, in barrels containing about three hundred pounds; the barrel to be made of seasoned, air-tight staves, to have twelve hickory hoops, and to be well papered.

Every tenth cask was subjected to the following tests:—

First. Mixed up in flat cakes of two inches in diameter, the moisture carefully dried from the surface, by means of blotting paper, until it was set enough to bear one fourth of a pound weight, on a wire of one twelfth of an inch diameter, and then put in water, where after the lapse of five minutes, it should bear one pound, on a wire of one twenty-fourth of an inch diameter.

Second. A similar sized cake, after the lapse of five days' immersion in water, was required to bear a load of fifty pounds, on a wire one twenty-fourth of an inch diameter.

Third. Two bricks united by the cement, and put in water five days, must resist one hundred pounds, before separating.

The above tests were made with water, at a temperature of 70° F. The mean of a large number of these tests, is as follows:—

The time to dry in air, to bear one fourth of a pound, on a wire one twelfth of an inch in diameter, was eight minutes. The time to set in water, to bear one pound, on a wire one twenty-fourth of an inch in diameter, was three and one-fifth minutes. Force required to thrust a wire, one twenty-fourth inch diameter, through cakes of cement two inches diameter, and three fourths of an inch thick, after being immersed in water twenty-four hours, was sixty-five pounds; after forty-eight hours immersion, seventy pounds; after seventy-two hours, seventy-five pounds; after fifteen days, one hundred and fifty-five pounds; after fifty days, three hundred and ninety pounds.

The joints of the masonry have been pointed up in the following manner:—Cement and sand were put in an iron mortar, slightly moist, and made nearly into an impalpable powder; this was driven into the joint, to the depth of an inch or more, by an iron caulking tool, and the upper surface rubbed with a steel tool, until it became very hard; in a few days, this pointing was nearly as hard as the adjoining stones.

The quantity of cement used in the construction of the Dry Dock, and its appendages, was twenty-nine thousand, one hundred and forty-seven barrels, costing, on the work, thirty-five thousand, eight hundred and ninety-three dollars and seventy-nine cents.

The first, or corner stone of the masonry, was laid, May 12th, 1847; but the foundation was not entirely completed, until June, 1848. The masonry of the Dock proper, was completed, the 19th of April, 1850, by the setting of the last coping stone. The cost of the masonry of the Dock (exclusive of cutting stone), has been, four hundred and twenty-eight thousand, eight hundred and seventy-five dollars and seventy-six cents.

For specifications of the masonry, description of materials, and the contract prices, see Appendix, Note D. The amount expended for cutting the stone of the Dock superstructure

(including the contract work), was two hundred and forty thousand, three hundred and thirty-five dollars and ninety-two cents; which amount should be added to the cost of the masonry of the Dock.

THE PUMP-WELL AND CULVERTS.

When the Dock is to be emptied, the water flows from the chamber through the galleries (shown in Plate Two, Figure Five), into the vaulted passages (Plate Two, Figure Seven), which unite at the head of the Dock, and is thence carried through the Draining Culvert, to the Pump-Well, which is placed under the east end of the engine house, as exhibited in Plate number One. The Pump-Well is built in an oval form, the two interior diameters being thirty and twenty feet. Leading from this Well, is a Discharge Culvert extending to the Bay, near the entrance of the Dock, for the purpose of carrying off the water from the draining pumps.

The work of securing a foundation for the Well and Draining Culvert, proved as difficult as that of any part of the Dock. The excavation of the Culvert and Well, was commenced in February, 1849, but was not urged until July of that year. From this date, bottom springs were met, of a similar character to those which had been encountered in putting down the most difficult portions of the Dock foundation.

The excavations were carried down to a depth, two feet lower than the foundations of the Dock, for the purpose of draining the water readily into the Well, thus tapping the stratum in which the powerful land springs are found.

The wasting away of the material by the violent flow of these springs, caused, in the first instance, the settling of the protection piling, and gave a sliding tendency to the grounds in the vicinity. To so great an extent did this take place, that at one time the stability of some of the permanent buildings in the Navy Yard was endangered.

During this settlement, the shores which had been put in to secure the curbing, became displaced and broken, by the enormous pressure against them: so much so, that it became imperative that they should be replaced with others of greater strength. As the excavation deepened, the flow of the springs increased, and before the piling was completed, and the concrete placed in, the action of the springs was such, as to force up many of the shorter piles, and in some parts of the foundation, cause others to settle.

Longer and larger piles were immediately put in, which drove the largest of the springs away from the centre of the work, and most fortunately, to places outside of the lines of the Well. In this place, as in other parts of the Dock, the most dangerous and difficult

part of the work, was the excavating for, and putting in, the concrete around the heads of the piles, in the foundations.

The floor of the Well consists of large blocks of granite, eighteen inches in thickness, the centre stone being the key of the arch, from which all the joints radiate, to prevent the action of the bottom springs disturbing the masonry. In addition to this security, it was deemed advisable, after the completion of the masonry of the Pump-Well, in 1850, to cover the whole surface of the stone floor with a cast-iron floor, formed of large plates with suitable ribs, and bolted strongly together: upon which the large pumps were founded, and the iron reservoir, supported by massive iron columns, reaching from the iron floor; as shown in Plates Ten and Eleven, and described more in detail, in Appendix, Note E.

The walls of the Pump-Well are constructed of cut granite, laid in cement. They are five feet thick, and carried plumb from the foundation to the top, forty feet, with the exception of four steps, on each side of the Well, as shown in Plate Ten. These walls were supported by buttresses of suitable dimensions, as exhibited in Plate One. The quantity of masonry in the Well, is two thousand, two hundred and eighty-three cubic yards. It was commenced in August, 1849, and completed in October, 1850.

The Draining Culvert, connecting the Well with the Dock, also the Discharge Culvert from the Well to the Bay, as laid down in Plate number One, were commenced in August, 1849; the former completed in November of that year, and the latter in October, 1850.

The foundations of the Draining Culvert being necessarily as deep as the Pump-Well, and in immediate connection with it, the same difficulties were encountered as in the former, and the foundations were required to be of the same character and cost.

The Discharge Culvert foundations were placed about ten feet only, below high tides, and were consequently out of the reach of the bottom springs, which proved so dangerous to the other foundations.

A portion of the foundation timbers of this Culvert, were placed upon some of the rows of the Coffer-Dam piles, which happened to be in the line of the work, parallel to the Dock; the residue was based upon three hundred and seventy-two piles, averaging twenty-four feet in length, and from fourteen to sixteen inches square (that had been drawn from the Coffer-Dam), and the whole covered with three-inch yellow-pine plank, to receive the masonry of the abutment walls, and the inverted brick arch between them.

The abutment walls of the Draining Culvert, are composed of granite, five feet thick on the bottom, four at the top, and four feet high. They are eight feet apart, and from them springs a semicircular arch, two feet thick. The bottom has an inverted arch of brick, laid in

cement, similar to the Culverts in the Dock, to guard against any remote danger, from the powerful land springs.

The Discharge Culvert abutment walls are also constructed of granite, four feet thick, and five feet in height, placed six feet apart, and covered by an arch, twenty-two inches in thickness. The bottom is lined with brick, forming an inverted arch between the walls. The quantity of masonry in these Culverts, is one thousand, two hundred and seventy-nine cubic yards. The cost of the Pump-Well and Culverts, was forty-three thousand, five hundred and nineteen dollars and eighty-nine cents.

Revetment or jetty walls were constructed, at the foot or entrance of the Dock, seventy feet in length on the east, and fifty feet on the west side; with flights of stairs, and convenient landings on each side, from small boats, built in the masonry. These walls were completed in April, 1850, and contain four hundred and sixty cubic yards of granite masonry, resting upon one hundred and ninety-eight piles, averaging each thirty-five feet long, and fifteen inches square.

THE ENGINE HOUSE.

The Engine House (see Plate Three,) is a fireproof building, three hundred feet in length, and sixty feet in breadth, presenting four fronts, of the finest cut granite ashler, with massive iron doors, iron shutters, iron window frames and sash; and the whole protected by an iron truss roof, covered with twenty-two ounce copper sheets, each twenty by seventy-two inches, as shown in Plate Thirteen.

The main building, seen in the Plate referred to, is one hundred and eighty feet in length; the wings are each sixty feet long, the right, or eastern one being entirely occupied by the large pumping engine, the boilers of which are in the main building, immediately adjoining the wing.

The floors of the engine and boiler rooms, are composed of cast-iron plates, five eighths of an inch thick, in star pattern, resting upon cast-iron girders, secured in the masonry. The floor over the boilers is made of rolled-iron plates, secured to cast-iron beams, supported by iron columns.

The first or lower floors, west of the boiler room, are constructed of cut stone, laid in cement, upon strong arches of masonry, that spring from the foundations of the building, and well secured by bearing piles of suitable lengths, driven with heavy hammers.

The walls of the building, above the water table, are three feet thick; those of the east

wing are composed entirely of granite, also the cross walls, between the east wing and the main building. The other cross walls, four in number, are constructed of brick, twenty-four inches thick; also the exterior walls, west of the engine room, are backed with brick. All the masonry is laid in cement mortar, made of one part cement, and two parts clean, sharp sand.

The following materials were used in the superstructure of this large structure:—

Twelve hundred and sixty-three cubic yards of fine-cut granite ashler; six thousand, nine hundred and thirty-three cubic yards of rubble masonry; one hundred and eighty-seven cubic yards of cut-granite floor stone; one thousand, three hundred and seventy-seven cubic yards of brick masonry. Below the roof of the building, there are; six hundred and thirty thousand, six hundred and thirty-six pounds of cast iron; one hundred and six thousand, and twenty-four pounds of wrought iron; three thousand, nine hundred and four pounds of composition metal; nine hundred and ninety-two pounds of steel.

In the roof there are; One hundred and twenty-three thousand, nine hundred and sixty-six pounds of wrought iron; fifty-five thousand, nine hundred and forty-one pounds of cast iron; fifty-seven thousand, seven hundred and five pounds of copper and composition metal.

The total weight of metal in the building, is four hundred and eighty-nine tons, eleven hundred and ninety-five pounds; of which, one hundred and eighteen tons, sixteen hundred and fourteen pounds, is in the roof.

The whole of the iron work and copper, is covered with three coats of the New Jersey brown zinc paint.

The foundations of the Engine House were commenced in the spring of 1849, and completed to the level of the water-table, in December of that year. The corner-stone of the water-table was laid in April, 1850, and the structure completed, as shown in the Engraving, the last day of August, 1851.

The original plan for this house, made in 1849, differed essentially, in very many particulars, from the one adopted in 1850. It was but three stories high, for the whole length of the building, with a fire-wall at each end of the roof; the doors, window frames, and sashes, also the girders and floors, were of wood, with the exception of the engine room; and the roof was to have been covered with slate.

The great cost of the engine and pumps, together with other valuable machinery, yet to be erected in this building, and its very close proximity to several extensive timber sheds in the Navy Yard, led to the adoption of iron and copper, in place of the materials originally proposed to be used, as the destruction or serious damage of the pumping engine, would be attended, with not only great cost, but the use of the Dry Dock would be lost, for a long

period of time. It may be now considered, one of the most complete, and fire-proof, engine houses and machine shops in this country, and is composed of materials of durable quality.

The cost of the building to this date has been:—three hundred and thirty-one thousand, forty-three dollars and fifty-six cents; of which sum, one hundred and fourteen thousand, four hundred and sixteen dollars and thirty-eight cents were expended on that portion of the house, west of the boiler room (not occupied by the engine and pumps of the Dry Dock); which is to be used as a machine shop, for repairs of vessels.

THE TURNING GATES.

In a report made to the Bureau of Yards and Docks, the 1st of October 1849, by the then late Engineer of the Dock (Mr. McAlpine), he states, that "a contract was made, September 25th, 1848, with Fortune C. Parsons, for the delivery of the timber for the Turning Gates, on or before the 1st of July, 1849. It became evident, very early, that he would be unable to procure and deliver the timber at his prices, without great loss, and it was doubtful whether it could be procured at all. My attention was called to the necessity of providing a substitute, in the event of a failure to procure the timber. The plan of making up the bars of bent plank, bolted together (as at the Boston Dry Dock), was considered objectionable. Mr. Pook, the Naval Constructor at the Boston Navy Yard, furnished me with a plan of a bar, made of one straight piece of large timber, and the curve formed by filling in the bar with solid wood. I had previously prepared a model of a trussed bar, which, to a considerable extent, avoided the expense of timber of such unusual and large sizes.

"During the investigation of this subject, I collected drawings of all the large gates of much importance, which had been lately constructed in Great Britain, and many of those on the Continent. The materials of which nearly all these gates were built, was wood; and generally upon the same plan.

"An examination of the subject, suggested the propriety of substituting iron for wood, for the following reasons:—

"The increased difficulty and expense of procuring timber of such large dimensions and form. The danger of inserting unsound timber, which could not readily be discovered, until it failed. The rapid deterioration in the strength of the gate, which required it to be constructed so massive, as to be more difficult of movement. The gates could be made of the required strength, of iron, with a greatly diminished weight. They could be repaired so easily and

cheaply, and would last so many years, without any other repairs, than to have them kept constantly covered with paint.

"Some large gates have been made of iron, in Europe, but the plans and descriptions of none of them have been published, except one pair, which were built at Montrose, in Scotland. I have, however, obtained much information on this subject, by correspondence, and from persons who have visited works, where iron gates are used. The first iron gates, that I have any account of, were built for the locks on the Ellsmore and Chester Canal, in 1800. They were made of cast-iron ribs, covered with oak plank; the post and ribs were cut in one solid piece. Each pair opened a space of fourteen feet in width.

"In 1823, gates for the locks on the Caledonia Canal, were constructed with ribs of cast iron, and covered by plank of English oak. These gates were about twenty-four feet long, and twenty-five to thirty feet high.

"Those at the Montrose Graving Dock, were made of cast-iron ribs, covered on both sides, with wrought-iron boiler plates, and cast-iron quoin and mitre posts. The leaves open a clear space of fifty-five feet, and weigh one hundred and seven tons.

"Iron gates of a similar plan, have been built for the docks, at Shinburness, Bristol, Sheerness, &c. At Bristol, one gate (or leaf) only is used, and it opens a clear space, forty-five feet wide. At Woolwich, the gates have a clear opening of sixty-five feet. Messrs. Rennie, of London, built seven pair of iron gates for docks, at Sebastapol, on the Black sea.

"It will be observed, that in the construction of all these gates, the ribs and posts have been made of cast iron. The low temperature of the atmosphere in this climate, renders the use of cast iron dangerous, where it is subject to violent concussions; yet (in the early stage of the examination) it was considered as impracticable, to procure wrought iron of the size and the form required, for the ribs of a gate for this Dock. After some correspondence with some of the large manufacturers in England, they concluded they could either roll these plates, or weld them up from shorter pieces. Plans were prepared for a gate, made wholly of wrought iron, except the quoin posts. The ribs were to be made of, alternately, *three* and *four* sheets of iron, secured by splicing plates.

"Some of the best practical engineers expressed doubts, as to the strength of the horizontal ribs of the gates, as thus arranged. To satisfy these doubts, a trial bar was modelled, after the form proposed, and full size, and subjected to pressure. It is believed, that no experiments have hitherto been made, at least none have been published, on the strength of iron thus applied; as they are very interesting, as well as valuable, they are herewith appended.

"The model bar was made of four plates of iron, twenty-two inches wide, and three fourths of an inch thick, with lapping plates over the joints, three feet long. The bar was first tested

by loading it, with the ends secured and resting against abutments. A weight of ninety-two thousand pounds was put on the middle of the bar, which deflected it two inches; the yielding of the frame prevented any further weight being applied, but it was subsequently tried without abutments, and deflected three inches with fifty thousand pounds; six inches, with sixty-five thousand; ten inches, with seventy-one thousand; and broke with seventy-five thousand pounds: the fracture being a rent, near the middle, extending up, from the lower edge, six inches.

"The result of the experiment, proved that the strength of a bar thus formed, has been under, instead of over, rated." The form and strength of the ribs having thus been obtained, the plan of the gates was readily arranged.

The details have, in many respects, been constructed essentially different from the original plan, designed in 1849. The proposed plan of opening and closing them, by means of four capstans and chain cables, was abandoned, and more simple and less expensive machinery introduced, as will be seen by reference to Plate Six, and to Appendix, Note F.

They have been constructed in the following manner:—The quoin posts are of cast iron, thirty-one feet, four inches long, twenty-six inches in diameter on the outside, and twenty-two inches bore; with four internal bands, each twelve inches wide, and eighteen inches bore; and a band on the bottom of the post, twelve inches wide, and twelve inches bore. On the outside of each post there are eight bands, projecting three eighths of an inch, to allow the fitting to the masonry. There are twenty-one lugs, two inches projection on one side, to bolt the curved bars, or ribs, of the gate to. The net weight of these posts are, respectively, thirty-one thousand, three hundred and eleven; and thirty thousand, eight hundred and ninety-four pounds; or together, sixty-two thousand, two hundred and five pounds—over *thirty-one tons.*

Each post has, at the bottom, inserted a socket, eighteen inches diameter, three feet long, and an interior bore to suit a footstep, ten inches diameter, and ten inches long, on which the post turns. The head of each post is secured in its perpendicular position, by a cast-iron anchor, with three limbs, each eight feet long, fourteen inches in width, one and a half inches thick, and secured to the coping of the Dock, by means of two-inch wrought-iron bolts, three feet long, leaded into the masonry; and a lip is cast on the anchor, at the centre limb, six inches in width, and at the side limbs, three inches, over which is placed an oval band of wrought iron, thirty-two and a half inches, by twenty-eight and one half inches in diameter, four by four inches, thus securing the vertical position of the post, when the gate is moved. The two mitre plates are composed, each, of one piece of wrought iron, thirty-one feet long, twenty-two and a half inches wide, and one inch thick; on the inside of which, there are riveted angle irons, six by three and a half and five eighths of an inch, to which the ends of the ribs are bolted, to correspond with the lugs on the post.

On one of these mitre plates, is fastened a buffer timber, of white oak, seven inches, by twenty-two inches, and the entire length of the plate, secured to the plate by means of two angle irons, six, by three and one half, by five eighths of an inch, also extending the whole length, and by bolts to the mitre plate.

There are twenty-one wrought-iron ribs to each leaf of the gate, curved to a radius of seventy-four feet, nine inches interior (which corresponds with the curve of the mitre sill), and seventy-six feet eight inches exterior. On the outer edge of the curve of each rib, and on each side, are fastened, by means of rivets, an angle iron, thirty-six feet long, four and a half by three inches. The four and one half inch side is secured to the ribs, and the sheathing fastened to the three inch side.

The first eight ribs from the bottom of the leaf are of three-quarter inch iron; the next twelve ribs above are of five-eighths inch, and the last or top rib, three-quarter inch iron. They are all thirty-six feet long, and twenty-two inches wide, made up, alternately, of three plates of twelve feet each, and four plates of nine feet each, secured together by means of lapping pieces, eighteen inches wide, and one-half inch thick, and sixteen one-inch rivets.

The sheathing is composed of the best Pennsylvania cold-blast plate iron, nine feet six inches long, by four feet nine inches wide, showing twenty-four inch water-lines.

The first six courses of plates, above the bottom of each leaf, are five eighths of an inch thick. The next four courses above, are one half inch thick. The next three courses above, are three eighths of an inch thick. The next two, and last courses, are one fourth of an inch thick. They are secured to the quoin post, by means of a rabbet provided for that purpose, and to the mitre plate, by means of the angle irons; the whole secured with rivets of half, five-eighths, and three-quarter, inch diameter.

The buffer timber, which closes against the mitre sill, is of white oak, twenty-six inches by sixteen inches, and secured to the lower rib by thirty-one one-inch diameter woodscrews; and to the sheathing by the same number of three-quarter inch screw-bolts, passing through the lower course of the sheathing and timber.

There is fitted into a recess, provided for the purpose, on the quoin post, India-rubber, eight inches wide, and three fourths of an inch thick, the entire length of the post, and secured to it by two vertical courses of three eight-inch tap-bolts, the heads of which are sunk to the level of the rubber, thus forming a tight joint between the hollow quoins and the post.

There are two sets of cast-iron tram-plates, eight inches wide and four inches thick, under each leaf of the gates, provided with lugs on each side, through which one-inch round lewis bolts are leaded into the stone floor of the Dock. They are planed on each side, and fitted to a perfect level, in the masonry. The respective radii, to the centre of these plates, on which

the friction rollers, which support the gates, travel, are thirty-one feet ten inches, and twenty feet, and to each of which, and the floor, are secured a set of spur segments, two and one half inches pitch, and five inches face; the one external, and the other internal, gearing, the radii of which are, respectively, thirty feet eight inches, and twenty-one feet two inches. Into each of these segments, a nine-inch pinion of the same face and pitch, work by means of a four-inch shaft, extending to four inches beyond the top rib of the gate. On the top of this shaft is a spur wheel, one and a quarter inch pitch, and four-inch face, which is operated by a pinion six inches diameter, to which is attached a two-inch shaft, extending three feet above the top of the gate, and a hand wheel of four feet diameter placed thereon, by means of which the gates are opened and closed.

Each leaf is also provided with a brass sliding-valve, thirteen by twenty-four inches, on the outside of the gate, and a two-inch screw shaft extended above the top of the gate, and operated in the same manner as described for the moving of the gates.

The bottom of each leaf of the gates is furnished with two composition rollers, of sixteen inches diameter, and six-inch face, through the centre of which is passed a cast-steel shaft, with journals, four by six inches, secured to pillow blocks, which slide in a casing, secured to the sheathing by twenty one-inch collar bolts each. On the top of each pillow block, and in the casing, there is inserted a composition nut, seven inches in depth, provided with a screw, on the upper end of which, rests a four-inch wrought-iron shaft, extending up the back of the gate eighteen feet, and secured to the gate by three cast-iron pillow blocks, fastened to the sheathing by six seven-eight inch diameter screw-bolts, each. This shaft is used to adjust and distribute the weight, over the whole external surface of the gates. Each leaf of the gates is surmounted by a bridge, formed of wrought-iron bearings, covered with yellow-pine floor plank, with brass railings, as seen in Plate Six, Figures One and Eight.

The forty-two ribs of these gates weigh one hundred and seventy-six thousand, and seven hundred pounds; and the two mitre plates, six thousand, three hundred and forty-nine pounds.

The total weight of the gates, including machinery for turning them, is one hundred and eighty-seven tons, eight hundred and ninety-three pounds.

The total cost, including the sum of nine thousand, six hundred and sixty-eight dollars and fifty cents, paid for the working machinery, was sixty-seven thousand, one hundred and forty-eight dollars, at the contract prices, for the following quantity of materials, and work done:—Two hundred and sixty-two thousand, two hundred and seventy-three pounds of wrought iron; ninety-seven thousand, eight hundred and thirty-seven pounds of cast iron; four thousand, five hundred and twenty-nine pounds of brass composition; three hundred and forty-three pounds of steel; four hundred and five pounds of India-rubber; two thousand, three hundred

pounds of brown zinc paint; sixteen hundred and ninety-four superficial feet of timber; the welding of one hundred and two thousand, nine hundred and forty-five pounds of iron; the planing, boring, turning, chipping, and drilling of five hundred and forty-three thousand, eight hundred and four superficial inches of iron and composition. For contract prices for the above, see Appendix, Note G.

These gates were commenced in the spring of 1850, and completed, ready for successful operation, the last of August, 1851: and were first used, on the occasion of the docking of the French war-steamer, "Mogador;" the 3d of September following, at which time the two gates were closed by four men only, on each leaf, with ease, in about *ten* minutes, notwithstanding their vast size and weight. They are perfectly water-tight, and will, undoubtedly, with proper care to keep them well coated with zinc paint, endure for very many years; and continue, for some time at least, to be the largest iron gates in this country or Europe.

THE FLOATING GATE.

The Floating Gate, or Caisson, is an iron vessel, with keel and stems, made to fit the grooves in the masonry, at the entrance of the Dock, as seen in Plate One, at B. By admitting water in this vessel, it settles into these grooves, and forms a barrier against the sea. It is removed from its place, by pumping out water sufficient to float the vessel clear of these grooves, the form or curve of which is seen in Plate Two, Figure Three. They are cut in the masonry, twenty-six inches wide, and twelve inches deep, from the top to the bottom of the side walls, and in the floor.

The Floating Gate is used, in case the turning gates require repair, or to relieve the strain on them, by dividing the pressure of the water

A reference to Plates Four and Five, will make more clear the following description of the Caisson of this Dock—the first, it is believed, that has been constructed wholly of metal.

Its exterior dimensions are fifty feet at the keel, and sixty-eight feet eight inches at the rail. At the first, or upper deck, it is sixty-seven feet long; at the second deck, sixty-five feet; at the third deck, sixty-one feet three inches; and at the fourth deck, or top of truss bracing, fifty-seven feet two inches. Beam at midship section, is sixteen feet, and at keel, seven feet.

The keel and stems are made of plates of three-quarter inch iron, and are two feet wide, and nine inches deep. The frame is made of vertical ribs of iron, bent to the form of the

vessel, and covered with boiler iron, and stiffened by angle-iron deck beams, and cast-iron tubes, as shown in Plate Five, Figures One and Three.

At the keel, the bottom plates are twenty-four inches wide, and three fourths of an inch thick, and the stems are of the same size. The sides of the keel are formed by bending the garboard streake at right angles to the bottom plate, and those of the stems, by a continuation of the side streakes, of which there are sixteen in number, made of boiler plate, nine feet long, by two feet wide. The first six of these, from the keel, are five eighths of an inch thick; the next four, half an inch; the next three, three-eighths; and the next two, for bulwarks, one quarter of an inch thick, with a lining of three-sixteenths inch iron, from upper deck to rail. They are all secured together, by three-fourths, five-eighths, and one-half inch rivets, at two and a half inches from centres.

The ribs of the frame are composed of wrought iron, as follows:—First futlock, or to the second deck, six by one inch; second futlock, or to the upper deck, five by one inch; and from main deck to rail, angle iron, two and a half, by three, and by half inch. The pieces of each rib are welded together, and butt at the centre of the keel, in castings provided for the purpose, and secured by rivets one-inch diameter. There are thirty-one ribs, on each side of the vessel, moulded to conform to sections, two feet apart, as shown in Plate Four, Figure One.

The knees, to which the sheathing is secured, are wrought iron, each limb being four by four inches in width, and fastened to the ribs; one knee on each side of each rib, secured by two one-inch rivets, as seen in Plate Four, Figure One.

Plate Five, Figures One and Two, show the cast-iron truss braces, which are five inches external diameter, and three inches bore, through each of which passes a two and a half inch bar of wrought iron, which is secured to the sides and keel plates, by keys passing through them and the bar, as in Plate Five, Figure Two, in large scale.

The kentlage table, seen in the same figure, is so arranged, that a passage way of two and a half feet high, is left between that and the keel, for the purpose of repairs and painting. The table is five feet wide, on which is now placed two hundred and eleven thousand, two hundred and ninety-five pounds of cast-iron kentlage, formed with sockets and pins, to fit one into the other, to prevent it from shifting. The top of the truss beams are moulded to four inches high in the centre, with provisions for laying on a deck, if required.

The truss braces and beams, commence at frame number one, alternately to frame number eleven, at which it terminates with cast-iron transom plates, running into the stem, at each end of the vessel, as shown in Plate Five, Figure Five. There are also two cast-iron transom plates at the stems, under each deck.

The beams and decks are all composed of wrought iron; the first are of angle iron, three

and a half by three inches, riveted to the frame at each rib, by six three-quarter inch rivets. The decks are lapped joints, with the exception of the main deck, which is butted, and crowns three inches. The decks are all riveted to the limb of the beams, by one-half inch rivets, and the main deck has counter-sunk heads.

The decks are supported in the centre by five cast-iron columns, six inches diameter, and four-inch bore; at each deck, from the keel to the main deck. Through each of these columns, there is passed a three-inch wrought-iron rod, from the main deck to the keel plate, secured by a key. Between each column, under the main deck, there are cast-iron Gothic braces, and on each wing there are also four cast-iron columns, similar to the centre ones, and a wrought-iron bolt, two and a half inches diameter, passing through each of them, from the main deck to the truss beams, and secured like the centre ones.

The filling tubes, four in number, are of cast iron, seventeen inches in diameter, and fourteen-inch bore, extending through the entire width of the vessel, riveted to the sheathing, and secured with keys to the ribs. Each one is provided with two valves (as shown in Plate Five, Figure Three), for the purpose of passing the water through the Caisson, into the chamber of the Dock; also into the interior of the vessel when required, from the same tubes, by four branch valves.

The last valves are used only when the vessel is being put into place, in the groove or recess of the Dock. They are of composition metal, cast in halves, planed and fitted together, and bolted through the chambers and flanges of the tubes, which are made in two lengths. These valves are operated by means of shafts and wheels, as shown on plan of second deck, Plate Five, Figures Three and Five.

To one of the tubes is connected a discharge pipe, from the pumps of which, there are two, double action, of the following dimensions, viz:—Sixteen-inch bore, and fourteen-inch length of stroke, operated in like manner to the ordinary fire engine, by breaks and levers, placed upon the main deck, as shown in Plate Four, Figure Two. These pumps are placed upon the third deck, and from them suction pipes extend to within twelve inches of the keel. In addition, a four-inch bilge pump is used, to take the water out of the interior of the keel, and from below the kentlage table, when required.

There are also two Kingston valves, operated as the other valves, at the bottom of the vessel, through which it can be emptied, when the chamber of the Dock is free of water, without using the hand pumps.

There are two capstans of cast iron, on the main deck, for warping the vessel; and cast iron heads, to secure the vessel when afloat. From the main deck, there are connected with the pumps, two pipes of three-inch bore, to be used for washing out the Caisson and chamber

of the Dock, and to be used in case of a fire in the vicinity, or on board of a vessel, when in the Dock for repairs.

Wrought-iron steps connect from each deck, and from the main deck to the rail. The joints of the sheathing and stems are chipped and caulked, so as to be water-tight, and the interior and exterior surface of the iron work is painted with three coats of zinc paint, to prevent corrosion.

A lining of India-rubber, eight inches wide, and one inch thick, was fastened to the exterior surface of the keel and stems, with counter-sunk screws, before the Caisson was launched, to prevent, as far as possible, the leakage of water between the vessel and the masonry of the Dock; which answered the purpose proposed, very well, until it became torn by repeated use of the Caisson, during the past year. Oak, or yellow-pine plank is to be used instead, arranged like the buffer timbers of the turning gates.

The contract for the Floating Gate was made in August, 1849; the iron keel laid in October of that year, and the vessel launched on the 1st day of January, 1850 (the day the contract expired), the whole of this complicated and massive structure having been built, from keel to rail, in the unprecedented space of seventy-two days and nights.

The following is the amount of material and work, in the Caisson:—

Two hundred and seventy-two thousand, six hundred and fifty-two pounds of wrought iron.

One hundred and forty-five thousand, five hundred and sixty-seven pounds of cast iron.

Two hundred and eleven thousand, two hundred and ninety-five pounds of cast-iron kentlage, for ballast.

Six thousand, three hundred and forty-four pounds of composition metal.

Eight thousand, nine hundred and seventy-four pounds of paint.

Seven hundred and sixty-five pounds of copper.

Nine hundred and seventy-nine pounds of India-rubber.

One hundred and forty thousand, four hundred and twenty-three pounds of wrought iron, welded.

Three hundred and forty-six thousand, two hundred and twenty-six superficial inches of chipping, planing, boring, and filing, of iron and composition.

The total cost of the Floating Gate, at the contract prices (see Appendix, Note G), was seventy-nine thousand, four hundred and nineteen dollars and sixty-eight cents. The weight of the Caisson is two hundred and seventeen tons, one thousand and eighty-one pounds, exclusive of the one hundred and five tons, twelve hundred and ninety-five pounds of ballast.

FILLING-CULVERT GATES.

The Filling Culverts open from the tide water, in the exterior face of the wing wall of the Dock, as seen in Plate Two, Figure Two, and have each a gate of composition metal, shown in Plate Nine. The seat of each gate is eight feet high, and two feet ten inches wide, presenting an opening to the galleries of the Dock, of three feet seven inches, by two feet three inches; provided with an interior projection of eight inches in width (as seen in Figure Two), and secured to the masonry by sixteen one and a half inch split lewis bolts.

The sliding valve is provided with a chipping piece, around its exterior and interior surface, forming a thickness of one and a half inches at those points, the webb of which is one inch thick, guided by slides secured to the seat by eleven three-quarter inch tap-bolts on each side. On the back of the valve, in its lowest extremity, is secured a nut, through which a three-inch screw shaft passes, and extends up the face of the Dock eight feet six inches. The head of the shaft is two inches, coupled to which, is a wrought-iron shaft of two inches diameter, extending three feet three inches above the coping stone, and fastened to it by a cast-iron pillow block, and at the top of the seat, by a composition one, operated at the top by a hand-wheel of four feet diameter.

The quantity of material in the two gates, was six thousand, four hundred and fifty-six pounds of composition metal; and the cost, twenty-three hundred and thirty-six dollars, and sixteen cents. They were completed in November, 1850.

DISCHARGE-CULVERT GATE.

On the west wing of the Dock, in the opening of the arch passage through which the water is discharged from the pump-well, eight feet from the front of the masonry, a gate is let into the Culvert by means of a check, provided in the stone work for the purpose, composed of composition metal, the opening of which is six feet by four feet, fastened to the masonry, as seen in Plate Twelve, Figure Nine, of the engravings. This gate is worked by a wheel and screw, the same as the Filling-Culvert gates; and is opened when the pumps are in operation, to allow the water to discharge into the Bay, and closed at other times to prevent the tides from setting up into the Culvert, especially when repairs are necessary to the Conduit.

The following is the amount of materials, and work in this gate:—

Sixteen hundred and forty-four pounds of cast iron.

Four hundred and ninety-eight pounds of wrought iron.

Three thousand, nine hundred and ninety-six pounds of composition metal.

Twenty-six pounds of copper, and three pounds of steel.

Twenty-six thousand, five hundred and one superficial inches of planing, boring, and chipping.

The cost of which, was nineteen hundred and thirty-six dollars and eighty-four cents. This gate was commenced in September, 1850, and completed in November of that year.

CULVERT GATES.

The Discharging Culverts, seen in Plate Two, Figure Five, through which the water passes from the chamber of the Dock to the draining culvert and pump-well, have each a side gate placed in the interior of the Culvert, under the main side walls, as exhibited in Plate Eight.

There are two swinging valves to each gate, as seen in Figure Seven; the smaller one presents an opening of fourteen by fourteen inches, and the larger one four feet square. It will be obvious, that the compound valve, used by opening the smaller one, whose surface, when the Dock is full and the Culvert empty, bears a pressure of three thousand, four hundred and sixty-eight pounds; while that of the larger is thirty-three thousand, seven hundred and eight pounds; an equilibrium is speedily produced in the Culvert, which renders it easy to open the main valve, and permit a full flow of water to the pump-well.

Figure One shows a wrought-iron shaft twenty-four feet long, and three inches in diameter, reaching from the top of the Culvert entrance to the coping of the Dock, secured in its vertical position by four cast-iron guides, each fastened to the masonry by four one-inch lewis bolts. This shaft at the coping connects with a hollow shaft, three feet three inches long, and five inches diameter at the base, and four inches at the top, through which a pawl passes, which is dropped when the machinery is not worked, and connected with a hand wheel four feet in diameter. (See Figures Eight, Nine, Ten, and Eleven, in detail.) At the lower end of the shaft is a bevel pinion twelve inches in diameter, with one and a half inch pitch, and four inches face, gearing into a three-feet wheel of the same pitch and face, which is secured to a four-inch wrought-iron shaft, extending horizontally fourteen feet, into the passage way to

the Culvert, for working the gates, as shown in cross section, Figure One, and elevation, Figure Two. This shaft is supported by three pillow blocks, resting on three cast-iron bearings (and secured to them by screw-bolts), which are fastened to the masonry by lewis bolts, as seen in Figure Twelve.

Four feet from the interior end of this shaft an eye-bolt is inserted, to which a curb-chain is attached, connecting with the lowest end of the smallest compound valve of the gate. The two valves swing on spindles of different lengths, the chain continuing to open the larger one, after the smaller jams upon its face, by a jaw, as shown in Figures Three, Four, and Seven. The main valve is secured to its seat by caps and bolts, which seat stands two feet into the Culvert, and is fastened by twenty, one and a half inch, composition lewis bolts. The valves are faced with India-rubber, by three eight-inch tap-bolts, and, with the seat, are of cast iron, as shown in cross sections, Figures Five and Six. They are painted, as also the other Culvert Gates, with zinc paint to protect them.

The following quantity of material was used in their construction, viz:—

Twenty-three thousand, six hundred and twenty-five pounds of cast iron.

Four thousand, and eighty-three pounds of wrought iron.

Six hundred and nineteen pounds of brass.

Eighty-one pounds of India-rubber.

Five pounds of steel.

Thirty-three thousand, seven hundred and eighty superficial inches of boring, chipping, and planing.

The cost was thirty-six hundred and thirty-five dollars and forty-two cents.

These gates were completed, November, 1850.

IRON CAPSTANS.

There are eight iron Capstans placed around the Dock, about ten feet from the coping,—two at the head of the chamber, and three on each side, each one of which are double-geared. Each Capstan is placed in a cast-iron box, five feet square and two feet deep, provided with a cover of the same material, which is secured to the box by six collar bolts, one and a half inches in diameter. Within this box are placed two sets of spur-gearing, the lower set being five to one, and the upper set as two to one. The top of the box has a cast-iron Capstan

head, eighteen inches high by fourteen inches in diameter, and worked by Capstan bars, connected with a hollow shaft through the top of the box. On the bottom of this shaft are the pinions which work into the spur-gearing, and through the same shaft is a pawl, which is dropped into the eye of the pinion, on which recesses are cut for it, thus changing the motion at pleasure. To each of these Capstans is attached a universal leading-block of composition metal, to which a line can be taken from any part of the Dock to the Capstan, to haul in or out the vessel. The Capstan boxes are sunk into the earth, to a level with the coping of the Dock, and secured to a framework of oak timber, bedded in concrete masonry.

The eight Capstans and fixtures have in them sixty thousand, two hundred and forty two pounds of cast iron.

Eighteen thousand, and twenty-one pounds of wrought iron.

Fourteen hundred and sixty-two pounds of composition.

One hundred and twenty pounds of steel.

Nine hundred and eighty-seven pounds of paint.

One hundred and seventy thousand, two hundred and seventy-five superficial inches of turning and chipping.

Their cost was eleven thousand, one hundred and forty-five dollars.

They were completed, August 30, 1851.

PUMPING-ENGINE AND PUMPS.

There are but few specimens of large pumping-engines to be found in the United States, and prior to the construction of this Dock, no one of magnitude, and adapted to this duty, had been built in America. This Dock, being by far the largest in the country, and located at the most important naval station, it was deemed important by the engineer in charge, at the time the plans were matured and adopted, (Mr. McAlpine), that the machinery for exhausting the water from the Dock should be of the most perfect kind, and of great power and capacity also, as but a very inconsiderable amount of aid is afforded by the recession of the tide.

In a report made by the engineer to the Bureau in 1849, he says, "My attention was early called to the necessity of providing the means of exhausting the water from this Dock in a rapid manner. After carefully examining the subject, I had plans and specifications pre-

pared, for a condensing vertical-beam engine, with a cylinder of fifty inches diameter, and fourteen feet length of stroke, and four lifting-pumps, each of fifty inches diameter, two of ten feet lift, and two of six feet lift; which I had the honor to submit to you on the 24th January, last.

"These plans and specifications, and the whole subject, were referred to a Board composed of Charles W. Copeland, a steam-engineer in the naval service; Wm. M. Ellis, engineer and machinist, of the Navy Yard, Washington, and myself. This Board was in session from the 27th February, to the 21st March, 1849, discussing and examining the matter.

"Mr. Copeland strongly advocated a double engine, working at right angles, but in all other respects essentially the same as the plan submitted. A majority of the Board (Mr. Copeland dissenting), adopted the plan of engine I had previously recommended to the Department, and the same kind of pumps, but only two in number.

"The engine and pumps were advertised, by the Department, to be contracted in March last, and were contracted by Gouveneur Kemble, of Cold Spring, New York, in May last, to be completed by 1st of January, 1850. I am unable to say what progress has been made in the work, because it has not been placed under my direction, but has been superintended by Mr. Copeland."

Owing to the expenditure of the appropriation, made in 1849 for this work, before the engine and pumps were far advanced, and to very many important alterations from, and additions to, the original or contract plans and specifications during their construction, they were not completed ready for use until the 16th of January, 1851, when the U. S. frigate St. Lawrence was docked; the water being entirely exhausted by the pumps in two hours and ten minutes working time, in the most satisfactory manner.

The duty performed by them in this short period of time, was as follows:—

To raise one hundred and ten thousand cubic feet of water, an average height of two and one half feet.

One hundred and twenty-five thousand cubic feet of water, an average height of seven and one half feet.

One hundred and fifteen thousand cubic feet of water, an average height of twelve and one half feet.

One hundred and ten thousand cubic feet of water, an average height of seventeen and one half feet.

One hundred and ten thousand cubic feet of water, an average height of twenty-two and one half feet.

Forty thousand cubic feet of water, an average height of twenty-six feet; making in all six hundred and ten thousand cubic feet.

A condensing double-acting beam engine, set in a cast-iron Gothic frame, and finished in the most perfect manner, as shown in Plates Ten and Eleven, with a cylinder of fifty inches diameter, and twelve feet stroke, works the pumps.

The working beam is of cast iron, thirty-one feet long between the "end centres," and four feet deep at the "main centre," strongly flanged and bolted, and weighing over fifteen tons. The piston-rod is attached to the beam by a parallel motion; the main-pump and air-pump rods are connected to it by double rods and links, the air-pump cross-head working in slides attached to the columns of the engine-frame.

The rod connecting the balance-wheel crank with the beam, is trussed by tie-rods, joined to each end of the rod, and to each other, by suitable bolts, and passing over a straining strut at the centre, with provisions for tightening the whole by screws and nuts. The balance-wheel is of cast iron, twenty-four feet in diameter, a cross-section of its rim having an area of about eighty square inches. Its arms (eight in number) unite in a centre case, having compartments to receive their tapered ends, and two of the segments have an interior counterbalance rim. The shaft and crank are of wrought iron. The condenser is formed from a portion of the air or vacuum chamber of the pumps, a partition being placed in that portion of it which extends above the reservoir bed-plate. The air-pump stands level with the condenser, is fitted with a floating cover, and sustains upon its upper flange the usual reservoir. The air-pump rod and bucket, the foot-valve and seat, are of composition metal. The length of stroke is forty-two inches, the diameter of the cylinder forty-four inches. The interior of the cylinder is lined with composition metal.

The piston, cylinder-covers, and steam-chests, side pipes, valves, valve-gearing, with the eccentric and rock shaft, are all nearly identical with those used in the best American steamboat engines.

There is an independent adjustable expansion-gear, so arranged that as the load upon the engine is increased by the lowering of the water in the Dock, a proportionate increased amount of steam is admitted into the cylinder. This is effected by a simple arrangement, consisting of a cam-wheel on the balance-wheel shaft, against which a cam-roller, suitably connected with the expansion-valve stems, is made to revolve; and along which it can be made to travel at any speed desired. The whole is rendered capable of adjustment by hand, or it can be thrown out entirely.

The front of the engine is mounted with steam and vacuum gauges, and an indicator, and

also a register for numbering the strokes of the pumps. The cylinder is felted and covered with a casing of mahogany, secured by brass bands. All the journals have automaton oil-feeders. The side pipes, rock-shaft and stand, and all the wrought-iron moving parts of the engine, are highly polished.

The frame of the engine consists of an entablature of cast iron, supported on double lines of Gothic columns and arches, ending against the walls of the engine room, which is fifty-four feet square, interior dimensions, and fifty feet in height, hard-finished walls, with heavy cornice. The whole rests upon the bed-plate of the engine, and upon granite base blocks, around the sides of the apartment. Each of the entablatures is secured to the walls of the building by four copper bolts, one and a half inch diameter, three feet long, with heads of three and one half inches square, and washers six inches square, passed through holes of one third greater diameter than the bolts, made in the stone walls of the house. Each of the ten pilasters are secured to the walls of the room, at three several points, with one and a quarter inch iron bolts, with counter-sunk nuts in the pilasters. There are also eight one and a half inch, iron bolts, of suitable length, extending from the west end of the engine frame, to the rear of the large granite chimney, to secure as far as possible the frame from longitudinal motion or vibration, to steady the engine, and relieve the walls of the building. To effect the latter object, prepared India-rubber of from one and a half to two inches thick, has been placed between the masonry and the iron entablature and pilasters, also India-rubber washers between the bolt heads and the exterior face of the walls.

The engravings referred to, show very beautifully the style of ornament that has been given to the whole work, care having been taken to have all the parts in keeping with each other. The engine is surrounded by an elegant iron railing, and a cast-iron flooring, figured in relief, covers the entire apartment. All the cast-iron work is painted with three coats of zinc paint, and bronzed.

The boilers are three in number, situated in a fire-proof room adjoining the engine, where careful arrangements are made to prevent radiation. They are, each, twenty-six feet in length, and seven feet diameter in the waist, built on the "single return drop flue" plan. The flues of all the boilers discharge into a transverse one, in the masonry underneath, connecting with the chimney, one hundred and twenty feet in height, and ten feet square at the top, as seen in Plate Three.

There are no feed-pumps attached to the engine, the boilers being fed from the rain-water cistern under them, by the direct-action steam pumps of "Worthington & Baker," of New York, each boiler having one attached to it. The general principle involved in its construction, is the combination of a pump with the steam cylinder, that drives it without the intervention

of a crank fly-wheel, or any device for producing rotary motion. The steam cylinder is in all respects similar to that of an ordinary high-pressure engine, with the parts as usually constructed for the admission and emission of steam. The engine and pump are both on the same frame, and have the same piston-rod, prolonged and attached to the plunger of a double-acting pump The steam-valves are actuated by an arm from the centre of the piston-rod, working against tappets or nuts upon the valve-rod, at each end of the stroke, in order to change the position of the steam-valve, and admit steam to alternate sides of the piston. The necessary reciprocating motion of the pump-plunger is thus produced in a very ingenious and simple way, with the least possible amount of friction and loss of power. The advantages claimed for this pump are many and obvious. The importance of an independent power, separate from the main engine, for forcing water into the boiler, has been long felt and acknowledged This pump supplies this demand, and enables the engineer to feed his boiler at all times, whether his engine be in motion or not, as it will continue in motion while steam is applied, and at any speed varying from ten to two hundred strokes per minute, as the wants of the boiler may demand, with very little care from the engineer.

The contract price of the Pumping-Engine, including boilers and iron frame, complete, ready for use, and warranted to perform the duty required for one year without repairs, was thirty-seven thousand, three hundred dollars, a sum much below its cost, after allowing the contractor for the additional entablatures and arches of the frame, extending to the sides of the building, and the pilasters against the side walls, as shown in Plate Eleven, amounting to seventy-three thousand pounds of cast iron, and which were added during the construction of the engine as necessary to secure it firmly in its position, and not disturb the masonry of the engine house.

There are two lifting-pumps, each sixty-three inches in diameter of cylinder, and eight feet length of stroke. As before mentioned, the plan of the pumps, the reservoir, &c., have been materially changed since they were contracted for, notwithstanding the plans had been made with much care by the commission appointed by the Department. The principal alterations and additions have been as follows, viz.: the contract states "There will be but *one* suction-pipe to *both* pumps, sixty-four inches diameter, with a suction-valve near the lower end, and a suitable air vessel at the upper end; suitable branches shall be extended from the suction-pipe to the pump-chamber. The draining-pumps, and air-pumps, and condenser, are to be placed upon a foundation plate, laid at a suitable distance (about nine and one half feet), below the bed-plate of the engine, and properly secured to the bed-plates and to the foundation walls."

The plan of the pumps, *as constructed*, is as follows:—

There are *two* suction-pipes, each sixty-three inches diameter, extending to the bottom of the well, and terminated in suitable rose-pieces, with ample apertures in the sides for the admission of water, as shown in Plates Ten and Eleven. There are also two suction-valves to the pumps, placed near the bottom of the suction-pipes, in addition to the usual one near the bottom of the pump-chambers. Each of these valves has suitable chests and bonnets, as seen in Plate Twelve, and is composed of vulcanized India-rubber, with the usual metal guard above. A disk of India-rubber, cut the proper shape, with punctures along its diameter, is slipped over the standards, tapped into the valve-seat, and secured by washers and the nuts of the guard; the India-rubber alone, from its flexibility, forming the hinge. The valve-seats are of composition metal, their faces being indented in such a manner as to require two sets of valves to each chest, and are divided into numerous apertures, by narrow but deep bars crossing each other at right-angles. This cross barring forms a support for the flexible material of the valve, and obviates all the difficulty to be apprehended from the tendency of the valve to collapse on being loaded. A perfectly tight and quiet-working valve is produced by this arrangement.

Each suction-pipe is furnished with a capacious branch-piece of the same diameter as the pipes, forming a connection with an air chamber, situated centrally between the pumps, and extending up to the bottom of the engine bed-plate. This air chamber, in addition to the support received from the branch pipes, is upheld by a centre column of great strength, resting on the iron floor at the bottom of the well, and extending up through the foundation plate, alluded to in the contract, through the centre of the air chamber, to the under side of the reservoir bed-plate. The air vessel and the condenser, as before noticed, are cast in the same piece, instead of being separated as in the original plan; which plan did not embrace the iron reservoir now made, thirty feet long, seven and a half feet wide, and eleven and one half feet high, with sides strongly ribbed, resting in part upon four heavy iron beams, thirty-two inches deep, projecting into the masonry of the well and held by bolts, and in part supported by four cylindrical pillars reaching to the iron well-floor. In the sides of this reservoir or chamber, opposite the mouth of the discharge culvert, leading to the Bay, through which the water passes from the pumps, are twelve panels, furnished with flap-valves of vulcanized India-rubber, opening outwardly, to prevent the rising tide from flowing into the reservoir and well.

The mouths of the pumps are placed at the level of mean low water in this reservoir, the bottom of which, forms a support to the heads of the pump cylinders, as well as a bed-plate for the air-pump and condenser of the engine. The bed-plate of the engine is of great weight, over sixteen tons, of the dimensions seen in Plate Twelve, and reaches across the largest diameter of the well, its ends resting upon the walls fitted to receive them, and its centre upon the reservoir, for a length of thirty feet. By this arrangement, a firm support

is furnished for the insistent weight of the upper works of the pumps, and the engine above.

The pump cylinders, suction and branch pipes, the air chamber and its supports, are of cast iron, flanged and ribbed, as represented in the engravings; the pump cylinders being lined with a staving of composition metal. The pump rods are double, and pass through stuffing-boxes in the floating covers, with which the pumps are furnished, as seen in Plate Twelve, and are secured to cross-heads, working in slides below the engine bed-plate. From these cross-heads double connecting rods extend directly to the beam of the engine.

The pumps are placed twenty-one feet from centre to centre, as shown in Plate Ten.

The quantity of material in the original plan of the pumps, would have been, if constructed according to it, and the specifications in the contract, ninety-six tons, eight hundred and fifty-six pounds, and two hundred and seventy-four thousand superficial inches of planing, boring, and chipping, costing, at contract prices, twenty-seven thousand, four hundred and five dollars. For prices, see Appendix, Note H.

The alterations from, and additions to, the specifications in the contract describing the original plan, have required, for the engine, pumps, reservoir, and iron well-floor, and supporting pillars, one hundred and seventy tons, eighteen hundred and ninety-five pounds of metal, and ninety thousand, four hundred and forty superficial inches of planing, boring, chipping, and filing, which, at the contract prices, cost twenty-five thousand, five hundred and thirty-five dollars and fifty-nine cents.

The following is the quantity of material in the pumping-engine, pumps, reservoir, and iron well-floor (exclusive of the engine as specified in the contract):—

Four hundred and eighty-four thousand, three hundred and eight pounds of cast iron.
Sixteen thousand, three hundred and eighty-one pounds of wrought iron.
Twenty-four thousand, three hundred and fifty-nine pounds of composition.
Seven thousand, six hundred and twenty-two pounds of copper.
Two thousand, and eighty pounds of India-rubber.

Making a total weight of two hundred and sixty-seven tons, seven hundred and fifty-one pounds, and a total cost of sixty-two thousand, nine hundred and forty-one dollars and twenty-nine cents, which amount added to the contract price for the engine, makes the aggregate, ninety thousand, two hundred and forty-one dollars and twenty-nine cents.

The above amount exceeds that charged to "permanent drainage," in Note K, of Appendix, by the addition of the percentage retained for one year from the contractor.

REMOVAL OF COFFER-DAM.

The removal of the Coffer-Dam, in front of the entrance to the Dry Dock, was commenced the 10th of October, 1849, and completed, so far as to admit the U. S. ship "DALE" into the Dock, the 8th of January, 1850.

As noticed in the construction of the apron of Dock, the *three* rows of Coffer-Dam piles, next to the interior of the work, were first cut off below the level of the floor timbers of the apron, for the purpose of adding to the security of the Dock foundations, by extending the flooring over them. This work was attended with much risk and danger, owing to the land springs, already described, and to the immense pressure of thirty-six feet head of water against the only *two* remaining rows of piles in the Dam; particularly during the unusually high tides in November of that year. By shoring and bracing the Dam against the masonry of the Dock, in the most substantial manner, and working large gangs of men day and night, it was removed without accident in eighty days, at the most inclement season of the year.

The *first* pile drawn from each of the outer rows of the Coffer-Dam, required a force of six hundred and thirty tons, to start them out of the earth and Dam. They had been driven by hammers weighing four thousand pounds, falling at the last blow from thirty to thirty-five feet, and had been in the Dam several years. They were from forty to forty-five feet in length, sixteen inches square, grooved and tongued.

After a vain attempt to start them with chain-cables and powerful levers, they were drawn by the aid of "Dick's Anti-Friction Press," worked by four men only.

The piles taken from the Coffer-Dam since January, 1850, have been mostly drawn by the use of "Bishop's Patent-Boom Floating Derrick," worked by horse power, at a cost, by contract, of four and a half dollars each, a sum less than the price they brought at auction after they were drawn.

The number of piles removed from the Dam, to this date, has been nine hundred and ninety-three, averaging forty feet long, and fifteen inches square. In addition to this, there has been taken from the Dam since October, 1849, three hundred and forty cubic feet of oak ribbon timbers; seventy thousand, three hundred pounds of iron bolts and tie-rods; sixty-two thousand pounds of chain-cables and anchors; and fifteen thousand, four hundred cubic yards of earth excavation, over one half of which was dredged from below low tide.

The removal of the Coffer-Dam, and the dredging of the channel in front of the Dock, to twenty-six feet depth of water, cost twenty-six thousand, one hundred and fifty-one dollars and thirty-eight cents.

EMBANKMENT AND DRAINS.

As the walls of the Dock were carried up, an embankment of coarse, clean gravel was filled in behind the puddle walls, placed next to the masonry, to cut off the springs. The material for this use, was taken from the Coffer-Dam, to the extent of about ten thousand cubic yards, the residue of over fifty thousand cubic yards was drawn from the hills in the vicinity of the Navy Yard, at an average price of twenty-five cents per cubic yard. The total cost of the embankment around the Dock, and the foundation walls of the engine house, has been fifteen thousand, five hundred and forty-three dollars and sixty-two cents.

A brick drain, three feet in height, and two feet in width (interior dimensions), has been built for a length of five hundred and fifty feet, extending from the discharge culvert, near the engine house, around the head of the Dock, and along its east side, to the revetment wall, being parallel to, and forty feet distant from, the rear line of the coping, to protect the masonry from the drainage of the yard.

COMPLETION AND COST OF THE DOCK.

This great national work, commenced in August, 1841, was entirely completed the 30th of August, 1851, having been ten years in progress of construction. The expenditures on account of the Dock, and its appendages, have been, to the date of its completion (as classified in Notes I, J, and K, of Appendix), two millions, one hundred and fifty-one thousand, one hundred and seventy-three dollars and sixty-one cents. To this sum there is to be added the percentage retained for *one year*, from the date of the completion of the pumping-engine, from which to pay for any repairs that might possibly become necessary (to meet the guarantee of the contractor), and the painting of the engine, pumps, and engine room, making the aggregate expenditures two millions, one hundred and fifty-six thousand, eight hundred and ninety-four dollars and seventy-six cents.

From this amount there should be deducted, from the sum expended for the engine house, one hundred and fourteen thousand, four hundred and sixteen dollars and thirty cents, being the expenditure for that portion of the house not required for the use of the Dry Dock, but intended as a shop for repairs of vessels, using the power of the Dry-Dock engine for driving

the machinery in it, and thus economize the power. There is also to be deducted from it, the sum of thirty-three thousand, six hundred and seventy-five dollars, for materials, engines, tools, and fixtures, disposed of during the last year of the construction of the work; and also, about ten thousand dollars' worth of engines, materials, tools, and fixtures, yet to be sold, that were originally purchased for the work out of the Dry-Dock appropriations.

This would make the cost of the Dock, and its necessary appendages, in round numbers, Two Millions of Dollars.

MACHINERY AND TOOLS USED.

During the construction of the Dry Dock, three steam-engines, of twenty, twelve, and six horse power respectively, were used at times to work the pumps for the temporary drainage, and the machinery for driving piles, unloading and setting stone, etc.; being fitted up with winding drums, by which power was conveyed to the numerous machines used to facilitate the progress of the work. It has been stated, that most of the piles for the Coffer-Dam, and foundations of the Dock, were driven by the aid of steam-power, a small proportion only of the whole number, having been driven by machinery, worked by men or horses.

The mud from the interior of the Dam was hoisted out by tubs suspended from the booms of the several derricks, and by cars moving on inclined planes, which were elevated by means of a rope leading to the winding drums previously mentioned. In like manner, the hammers of the piling machines were elevated, the heavy stone were hoisted and lowered on the cranes and derricks; the grindstones, saws, planing and grooving, and screw-cutting machines, were put in motion.

The stone for the Dock were chiefly transported from the wharf on cars; lines of railroad encircled the pit, from which branches led to within reach of the discharging-cranes, the piling-derricks, and the laying-derricks. Of the former there were seven along the wharves and Coffer-Dam, by means of which, an equal number of vessels could be discharged at the same time. This number was necessary, as in many cases the vessels loaded with stone, arrived in fleets. As the stone were hoisted out of the vessels, they were loaded on cars, and transported to the stone-cutters' sheds or piling-derricks, where they were assorted and piled away. Thence they were taken, as required, to the laying-derricks placed around the margin of the pit. The discharging-cranes were cheap machines. The piling-derricks were chiefly the old excavation-derricks refitted. The limited area of ground necessarily assigned, by the officers of the Navy

Yard, for the use of the Dry Dock, on which to put the material used in its construction, rendered it not only necessary, but very expensive, to pile up the enormous mass of stone used in this work, as will be seen by reference to the item of "Receiving and Transporting Materials," in Note K, of the Appendix.

CONTRACTORS OF THE WORK.

The names of, it is believed, all of the original Contractors, for materials and work of this Dock, are given in Appendix, Note L.

On a work of such magnitude, occupying ten years in its construction, under the personal supervision of *five* chief engineers, employed at different periods of time, it was of the first importance to the prompt and successful execution of the plans of the engineer in charge for the time being, as well as for the best interests of the Government, that the Contractors should possess proper experience, energy, and responsibility, combined with the requisite ability to faithfully execute their contracts; especially those for furnishing the granite for the Dock, the construction of the iron gates, engine, and pumps, and the iron work of the engine house, all of them, in their execution, requiring much labor, skill, and capital.

The annual reports of the several engineers in charge of this work, to the Bureau of Yards and Docks, bear testimony that the Contractors engaged on it were of the first class, and while all are favorably mentioned, those having the important contracts named, are particularly commended for the skill, energy, and promptness, evinced in the execution of their contracts.

The construction of the *largest*, and it is believed the *first* Floating and Turning Gates, composed wholly of metal, and mostly of *wrought* iron, has been successfully accomplished by Gen. Henry R. Dunham, of the firm of Henry R. Dunham & Co., Archimedes Works, New York, assisted by his brother, John Dunham, Esq., who had the personal supervision of the contractor's work, and contributed many valuable suggestions respecting the details of their construction during the progress of the work. Much credit is also justly due to Horatio Dixon, Esq., the experienced mechanical engineer, who was appointed by the engineer of the Dock, inspector of these gates, and under the direction of the engineer made the original plans for their construction, and subsequently added many improvements of his own invention.

The erection of the engine and pumps, which in magnitude and power are not equalled in America, and exceeded in dimensions only by those which have within a few years been con-

structed to drain the Haarlem Mer, in Holland, is due to the Hon. Gouverneur Kemble, of the West Point Foundry, Cold Spring, New York, under the personal supervision of the experienced and skilful engineer (Mr. Rumpf), and the able superintendent (Mr. Lawson), of that foundry.

To the engineer, Mr. Rumpf, most of the credit is due for the many important additions and improvements that were made in the arrangement and construction of the pumping-engine and pumps, (which have been heretofore noticed,) and differing very materially from the original plans furnished by the commission appointed by the Department. The difficult and responsible task of properly erecting this large mass of machinery, on the stone foundations and within the walls of the engine house, was intrusted by the contractor to Mr. George Williamson, one of the experienced and capable engineers of his foundry, who performed the work in a very creditable and satisfactory manner, and who has had the charge of the engine and pumps since their completion.

OFFICERS AND MEN EMPLOYED.

In Note M, of the Appendix, the names of the officers and the average number of men employed, during the entire construction of the Dock, are given. It will be readily seen that it would be impossible, in this connection, to refer to the qualifications and services of the many officers who have been employed in important and active duties, during the progress of this work. Nor is it, perhaps, necessary to state more than to record the very general testimony given by the different engineers, of the competent and faithful discharge of their duties, in the various positions assigned them by the engineer in charge.

REGULATIONS ON THE WORK.

In employing the large force necessary to construct this work, it was considered important to excite emulation among the foremen and workmen. For this purpose, an account of the performance of each gang or individual was taken each day, as far as the nature of the work rendered it susceptible of measurement.

The number of barrows of earth wheeled out by each gang of men; the length and number of piles driven by each machine; the quantity of concrete masonry put in; the number of

stone discharged from the vessels by each crane; the superficial feet of each description of granite cutting; and the cubic yards of masonry laid, were daily reported to the engineer, together with a report at each muster call, morning and noon, of the names of all the persons employed, who answered to their names.

The effect of this arrangement was to produce a much larger amount of work than would otherwise have been obtained, and it also enabled the engineer to put a fair value on each of the foremen, and very many of the workmen's services, as will be seen by reference to the rules adopted for conducting the work, given in Note N, of the Appendix.

CONCLUDING REMARKS.

Having completed the description of the various parts of the Dock, and the mode of their construction, it only remains to add, in conclusion, a few remarks descriptive of the manner of using the Dry Dock, for the purposes for which it has been constructed at so great an expenditure of time and money.

When a ship is to be docked, the filling culverts are closed, as well as the passages from the Dock chamber to the draining culverts, leading to the pump-well, and the water is pumped from the latter. The ship is then admitted and placed over the keel blocks, in the centre of the Dock; the Caisson is floated to its place, over the recess or groove, and then filled with water until it sinks down to the bottom of the masonry fitted to receive its keel. The ponderous turning gates are then closed by men standing on the bridge, and working the four hand wheels that move the machinery.

In this situation the culvert gates in the Dock chamber are drawn, and the water allowed to flow into the draining-culvert and well, and thus, in a few minutes, the water is lowered several inches in the Dock, to hasten the shoring and produce an immediate pressure on the gates, so as to effectually prevent the admission of water, and fix them steadily.

A complete command of the level, at the moment the gates are closed, or when a ship, especially a large one, is about to touch the blocks, and require the placing of shores, is important; and this mode gives a more perfect control of the operation for the first foot, than could be obtained by the best regulated pumps, and machinery for driving them.

The water remaining in the Dock (in quantity about six hundred thousand cubic feet), is afterwards pumped out of the well into the reservoir, from which it is discharged into the culvert or conduit leading to the Bay.

As the water is lowered in the Dock by the pumps, the ship is supported in its vertical position on the keel blocks, by shores placed on the floor of the Dock, and the side altars, and is then ready to undergo repairs, which, in this vast structure, can be conducted with great facility and security.

From the 1st of January, 1850, the day when the U. S. sloop-of-war "Dale" was docked, by simply using the Caisson, and the pumps erected for the temporary drainage of the foundation pit; to the 1st of January, 1852, there have been docked, in addition, the U. S. steamer "San Jacinto" (three several times), the U. S. frigates, "St. Lawrence," "Brandywine," "Constitution," "Macedonian," the store-ship "Relief," and the French steam-frigate "Mogadore," all of which have been safely docked, the last five, since the completion of the permanent pumps, in January, 1851, on an average of two hours and twenty-two minutes' working of the pumps, and four hours and fifteen minutes from the commencement to completion of each docking.

BOSTON DRY DOCK.

HISTORY.

THE granite Dry Dock at the Boston Navy Yard was commenced in June, 1827, under the charge of Colonel Loammi Baldwin, as chief engineer, and Captain Alexander Parris, assistant engineer, both of whom continued in charge of the work until its completion in March, 1834. Previous to the entire construction of the Dock and its appendages, the United States frigate "Constitution," was docked on the 24th June, 1833.

This, the first national Dry Dock, was begun under the administration of John Quincy Adams, and completed under that of Andrew Jackson. The Hon. Samuel Southard was the Secretary of the Navy at the time of commencement, and Commodore John Rodgers, President of the Navy Board.

On the 28th March, 1827, the Secretary of the Navy appointed Colonel Baldwin, engineer, to superintend the construction of the Boston and Norfolk Dry Docks. He proceeded at once to locate those Docks, and make the general plans for their construction; and on the 12th of the following June, commenced the work upon the Coffer-Dam, employing thereon as many workmen as could be advantageously engaged. The Coffer-Dam was completed so far as to shut out the tides the next spring, and the excavation of the pit begun. The bearing piles were driven during the year 1828, and the foundations were so far completed as to lay the corner stone of the masonry on the 21st May, 1829.

Great delay was caused by the difficulty of procuring a supply of suitable stone for this work, owing to the failure of several contracts, and the unusual severe winter of 1830 and '31, together with the nature of the work, its novelty in this country, the limited area in which it was necessarily carried on, and the difficulty of procuring suitable workmen in sufficient numbers to properly construct the Dock.

The Dock was so far completed, as to be delivered into the charge of the commandant of the yard on the 9th of September, 1833.

DESCRIPTION.

The Boston Navy Yard is located at the junction of the Charles and Mystic rivers, in the south-east part of the town of Charlestown, opposite the city of Boston, and at the south-west corner of that yard, on the bank of the Charles river, is located the Dry Dock.

The surface of the site upon which this Dock was built, was about nine feet below ordinary high tides, at the time the excavation for its foundations was commenced. The first eighteen inches in depth excavated, was marsh mud, then five feet blue clay, then thirteen feet yellow sand and gravel, mixed with large stones, then hard blue clay to the bottom of the foundation pit, occasionally interspersed with small strata of hard and loose sand of various colors, and gravel with boulders.

The quantity of water met with in the various strata of sand and gravel was considerable, though no single springs of great magnitude were found.

The piles were driven three feet from centres each way, but were very irregular in their lengths when the hard pan or rock was reached. In some instances the piles would reach rock in eight or ten feet, in others they were driven to the depth of thirty feet, all however reaching firm bottom. The timbers on the piles were arranged in the same manner as the New York Dock, and the foundations completed as described for that work, excepting that no *concrete* is used on this work around the heads of the piles.

The Masonry of the Dock is composed of Eastern granite of the best quality, the face-work finely cut, and laid in cement mortar, made of two parts of clean sharp sand, and one part of best hydraulic lime. The exterior dimensions of the Dock are, length three hundred and forty-one feet, breadth one hundred feet.

The interior of the chamber at the top is eighty-six feet wide, and two hundred and fifty-three feet in length, to face of arch above the mitre-sill, being the portion that can be used for docking vessels inside of the turning-gates. In addition to this, the space between the turning and floating gates, fifty-three feet, can be used by blocking up to the level of the mitre-sills, making in all three hundred and six feet length of Dock. The width of the chamber floor is thirty feet, and length two hundred and twenty-eight feet. The depth from coping to the mitre-sill is thirty feet; depth of water at ordinary high tide over mitre, twenty-five feet. The rise and fall of tides is usually eleven feet at this Dock.

The stone floor of the Dock is five and a half feet in thickness at the head, and four feet at the foot of the chamber; at the mitre-sills and arches, six feet, and under the turning-gates, four and a half feet in depth. The breadth of the side walls of chambers at their base, is thirty-five feet, reduced, by offsets forming the altars, to seven feet at the coping. The width of the altars from the top, are as follows, viz.: three of two feet each, one of four feet, two of two and one half feet each, one of four feet, three of two feet each, and one of three feet, making eleven in all; the first four of which are each four feet four and one half inches in depth; the next three, each three feet; the next three, each one foot; the next, one foot. In addition to the above, there is a broad altar at the bottom, which shows fifteen inches rise at the foot of the chamber, and corresponds with the level of the floor at the head.

The details of the masonry of this Dock differ mostly from that of the New York Dock in the smaller dimensions of the stone, and the arrangement of the altars, timber slips, and steps. This Dock has a timber slip at its head of five feet wide, from the top to the bottom, divided into three divisions, with landing places on the broad altars. In the centre of the chamber, on each side of the Dock, there is a flight of stone stairs, and also two similar flights at the lower end adjoining the main arch, for the accommodation of the workmen engaged upon the vessels being repaired. On each side of the entrance to the Dock is a jetty wall, projecting thirty-five feet into the river.

The Side Culverts in the walls of the Dock, leading from the chamber to the receiving culvert, are built of hard brick, with straight side walls and semicircular tops and bottoms, fourteen inches in thickness, laid in cement. The opening of each culvert is four feet high, and two and one half feet wide.

The Receiving Culvert, across the head of the Dock, is twelve feet high and seven feet wide, built with cut stone sides, and a semicircle top of brick, fourteen inches thick, and an arc of a circle lining of brick of the same thickness.

From one end of this receiving culvert a brick tunnel, of about eighty feet in length, four feet high, and two feet nine inches wide, of an elliptical form, leads to the wells.

The two Pump-Wells are each fifteen feet nine inches in diameter, and connected together, being made in this manner to afford a firm foundation for the pumping engine and pumps. The wells are built of brick, the bottoms being inverted arches two feet thick, the side walls are two and one half feet in thickness, having four projecting courses of cut stone at proper intervals to support the pump-frames. The tops of the walls are coped with stone, one foot deep and eighteen inches wide.

There were originally placed in each of these wells, four lift-pumps and four chain-pumps. The chain-pumps were found on trial to break very frequently, and were soon taken out, as it was ascertained that the eight lift-pumps would use the whole power of the engine, and exhaust the water from the Dock in six hours, being about as rapidly as a ship could conveniently be shored.

The eight Lift-Pumps are each thirty inches in diameter, and three feet stroke, made of cast-iron, lined in their chambers with composition staves; also, have boxes and valves of composition. The pumps are driven by pinion wheels fitted on each end of the engine-shaft working into cog-wheels on the shafts of the pumps.

The Engine House is built of cut granite, one hundred feet in length, and forty feet in breadth, three stories in height, and covered with a slate roof. Sixty feet of the lower story of this building is occupied with a pendulum engine of sixteen-inch cylinder, and four feet stroke, and five plain cylindrical iron boilers, each thirty inches in diameter, and twenty-six feet in length, using anthracite coal for generating steam. The residue of the structure is used for a saw-mill and machine shops.

The Culvert Gates, placed on each side of the entrance to the Dock, are made of composition, two and one half feet square, and are raised for the admission of water into the chamber, by means of a screw-shaft and key.

The Discharge Culvert, that conveys the water from the pumps to the Bay, is about four hundred feet in length, and made of brick, with an opening three feet square, at the mouth of which is a composition gate.

THE TURNING GATES are constructed of timber and composition, and covered with copper. Each leaf is thirty-six feet wide, and thirty feet eight inches in height, and is composed of a top and bottom rib of oak timber, twenty by twenty-four inches square, and ten intermediate timbers eighteen by twenty inches square, all of which are connected with a hollow quoin-post of white oak, two feet diameter, of thirty-one feet long, projecting four inches above the coping of the Dock, and the head secured in its position by an iron strap, keyed to anchors laid in the masonry. The bottom of the quoin-post has a composition saucer fitted into the timber, and a composition pintal let into the stone-work to fit it, upon which the post moves. There is a mitre-post to each leaf, two feet square, into which the ribs are also secured at the opposite ends of them from the post. The ribs are planked diagonally with three-inch yellow-pine plank, secured firmly with composition spikes, and covered with thirty-two ounce sheathing copper, to protect them from the worm. There is a foot-bridge across the top of the gates for the convenience of the workmen to pass over the chamber of the Dock.

Each gate has two composition friction rollers, each twenty inches diameter, and six inches face, running upon cast-iron tram-plates seven inches thick, ten inches wide on the bottom, and eight inches on the top. The gates are moved by means of chains of three-quarter-inch wire, wound around a spiral cast-iron drum attached to a cast-iron shaft of seven inches diameter, which shaft is connected at the centre of the well to another shaft of five and a half inches in diameter by means of gearing. The upper shaft is turned by an iron capstan three feet high, worked by six bars or levers, each seven feet in length.

THE FLOATING GATE is built of white-oak timber and yellow-pine plank, fastened with composition and copper bolts. The dimensions of the gate are, length sixty feet, height thirty feet, and breadth amidships sixteen feet. The keel and stems are each two feet thick, and project fourteen inches into the stone-work or recess of the Dock. Through the centre of the gate, from stem to stem, there is a solid wall of timber two feet thick, extending from the keelson to the deck of the boat. This partition wall is built of twelve-inch square oak, scarfed and firmly bolted together, and secured at their ends into the stems by copper bolts. At five points in this centre wall there are perpendicular timbers or posts, each twelve inches square, reaching from the top or upper deck to the keel, where they are dovetailed and keyed. In addition, there are on each side of the gate eleven oak ribs, twelve inches thick, and twenty-six inches wide, tusked at their ends into the centre partition timbers, and strongly fastened with copper bolts. There are also three courses of braces or tie beams, ten inches square, passing through the centre wall, and bolted to the side ribs to resist the pressure of the water. Three feet below the top rail is the deck of the boat, on which the pump-breaks

are placed. The sides of the vessel are planked with four-inch yellow pine, secured by copper bolts and covered with copper sheathing.

There are on each side of the partition through the boat, four copper ship-pumps, each eight inches diameter, worked by common fire-engine brakes; which, with twelve men to each side, exhaust the water in the Caisson in one hour and a half, when the gate is to be taken out of the groove to admit a vessel into the Dock.

The floating gate originally proposed for this Dock by the engineer, Colonel Baldwin, was intended to rest against the shoulder at the entrance, so that when brought to its place, it should be retained there, on pumping out the Dock, by the horizontal pressure of the water. In that case neither the floating gate, nor the turning gates, would serve to retain the water inside the Dock, at a level above the tide, so that the water in the Dock would necessarily fall with the tide.

This circumstance might at times lead to serious inconvenience, if not danger, in docking a large ship, if it should ever happen, that by accident or otherwise, a ship should not be sufficiently shored and supported before she should be allowed to keel on the blocks. To guard against evils of this kind, the engineer concluded to construct the floating gate, and the masonry of the Dock, in such a manner as to let the gate drop into grooves in the side walls and bottom, so as to resist pressure in all directions. With a gate constructed in this way, and sunk into the grooves, the water in the Dock may be retained at its original level for a convenient space of time, while the tide outside may fall several feet below it, and the gradual and requisite discharge for securing the shoring a ship, obtained by the pumps.

The Cost of the Work was six hundred and seventy-seven thousand, eighty-nine dollars and ninety-eight cents, for details of which see Appendix, Note O.

NORFOLK DRY DOCK.

The Dry Dock at the Norfolk Navy Yard was commenced in November, 1827, and completed in March, 1834, under the direction of Colonel Loammi Baldwin, chief engineer, assisted by Captain William P. S. Sanger, the present engineer of the Bureau of Yards and Docks.

The ship of the line, "Delaware," was docked on the anniversary of the battle of Bunker Hill, (17th June, 1833,) being the first national ship ever docked in a Dry Dock of the United States.

The Norfolk Navy Yard is located on the southern branch of the Elizabeth river, adjoining that part of the town of Portsmouth called Gosport, about one and a half miles from the city of Norfolk, Va. In the south part of this yard the granite Dry Dock is situated. The original surface of the site upon which this Dock was built, was about six feet above ordinary high water, when the excavation was commenced for the foundations. The soil for the first eleven feet from the surface was a yellow sand and loam, then two feet of red and yellow wet sand, then one foot of red sand and gravel, then two feet of blue clay and sand, then eighteen inches of blue clay and oyster-shells. At this depth, a very firm, compact blue clay was found, which continued to the bottom of the excavation, and under this clay there is a stratum of hard gravel, into which an auger would not penetrate, and which contained a copious supply of water. The foundation piles were driven the same distance apart as at the Boston Dock, and reach the hard gravel. At the entrance of the Dock the piles are about thirty feet long, and they diminish very gradually in length towards the head of the Dock, where they are about fifteen feet only in length. After they reached this stratum of

gravel, it was not found practicable to force them into it more than a few inches. The power of the water was found such as to cause it to rise through the pores of the piles, and flow over their tops after they had been cut off level with the bottom of the pit. The summit of the spring was found to be twenty feet above the foundation, and ten feet below tide, and this was the only spring of consequence met in the excavation.

The dimensions and character of the work of this Dock, are almost precisely similar to the one already described at the Boston Navy Yard, having been built from the same working plans, under the direction of the same chief engineer, and need not therefore be again specified. The engine house at Norfolk is of the same length and breadth as the one at Boston, but only two stories in height, and is constructed of brick. The engine and pumps are alike at both Docks. The discharge culvert is only half the length of that at the Boston Dock. There is also a very slight change in the side steps of the masonry at the centre of the chamber. These are all the variations in the two structures.

The Cost of the Work was nine hundred and forty-three thousand, six hundred and seventy-six dollars and seventy-three cents, as classified in Note O, of the Appendix.

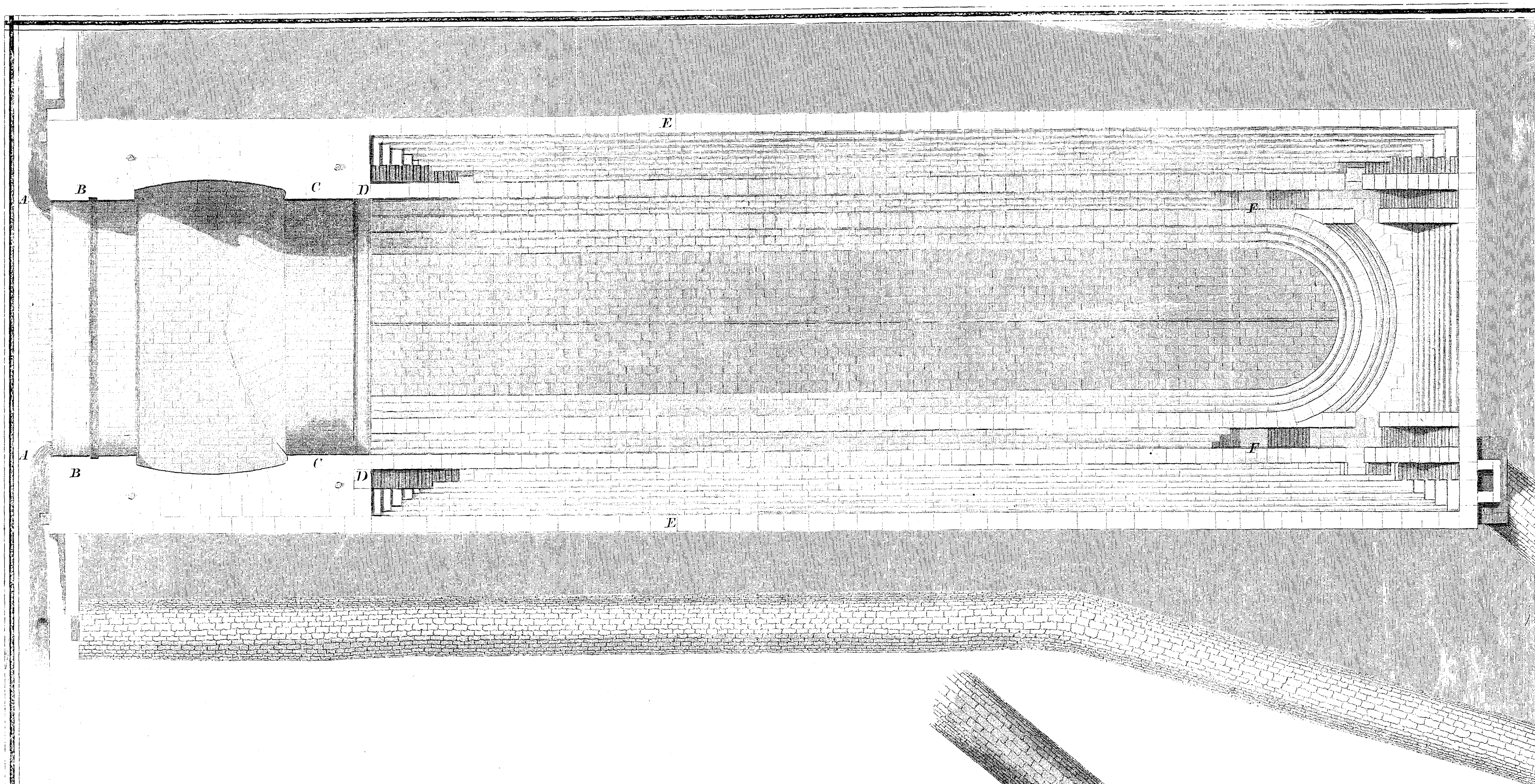
DESCRIPTION OF PLATES.

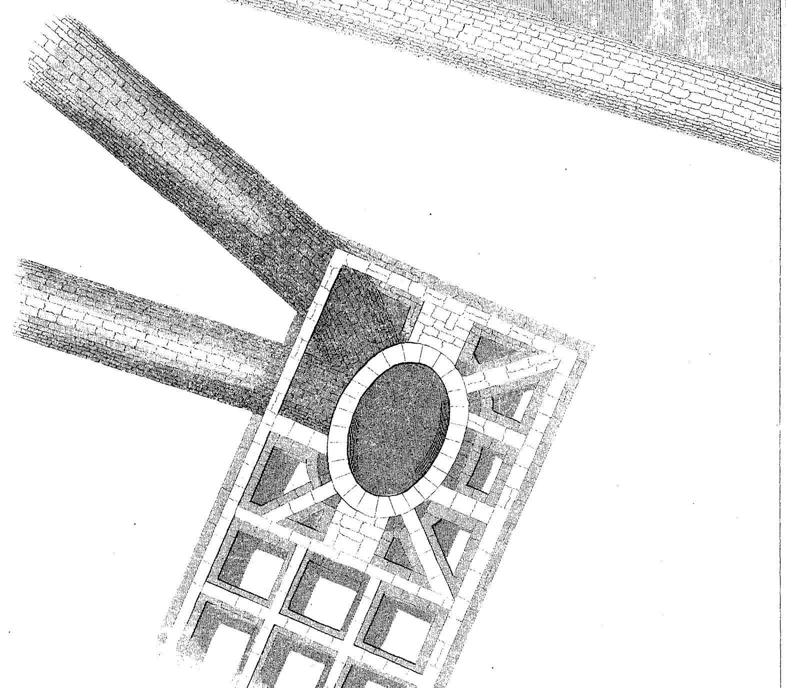
PLAN OF DRY DOCK AND PUMP-WELL.

Description of Plate One.

Plate One, shows a plan of the Dry Dock (with boat landing and steps), part of the engine-house foundations, pump-well, receiving and discharging culverts. The letters A, B, C, D, E, and F, marked on the coping of the Dock, are at the points referred to in sections, in Plate Two.

The broken lines of culverts show, when connected, the location of the pump-well and engine house, in reference to the Dock.





PLAN
OF
DRY-DOCK, ENGINE-HOUSE,
PUMP, WELL, RECEIVING & DISCHARGING CULVERTS,
UNITED STATES NAVY YARD.
N-Y

W. L. Ormsby, New York.

SECTIONS OF DRY DOCK.

Description of PLATE TWO.

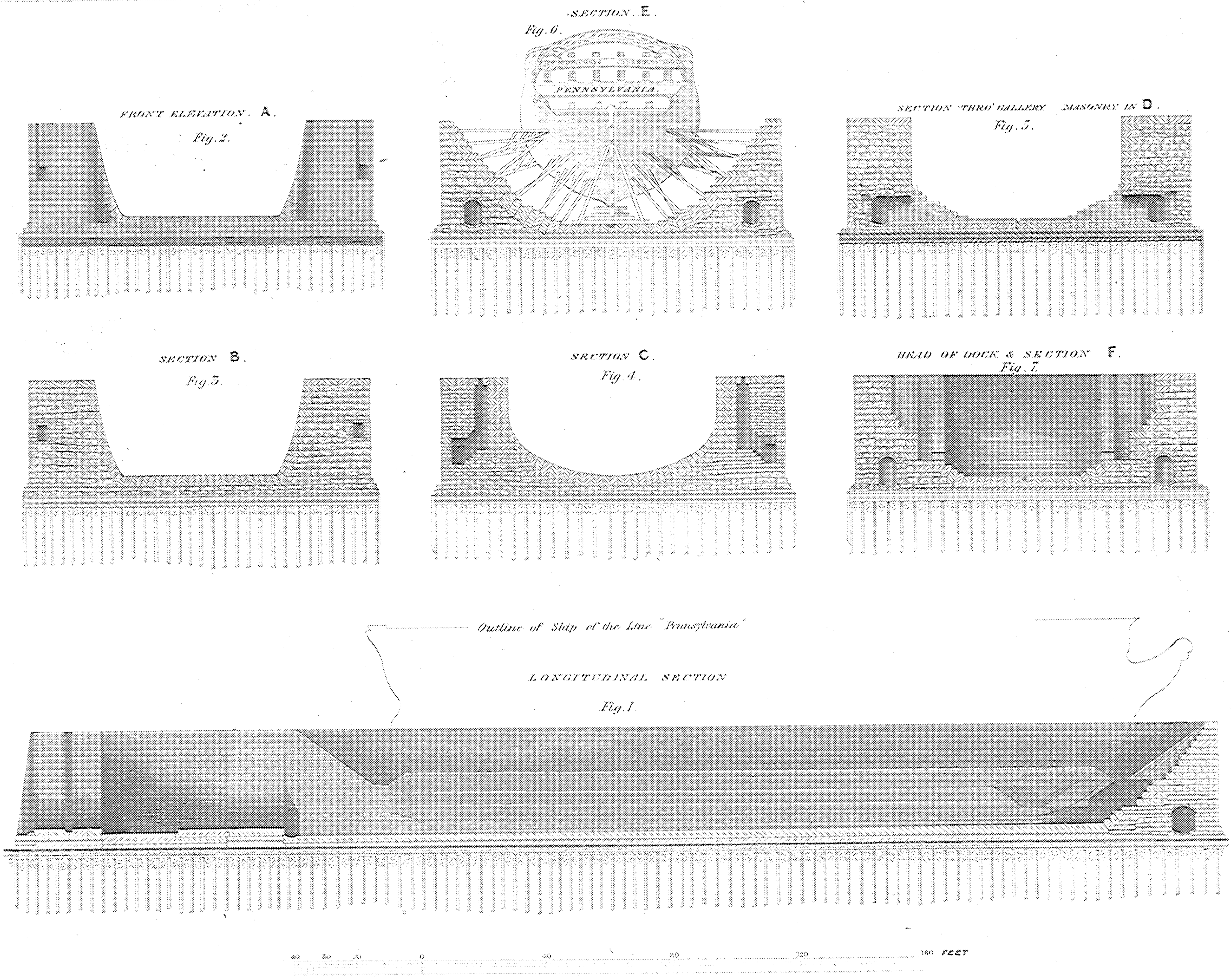
FIGURE ONE, is a longitudinal section of the Dry Dock, showing the outline of the ship of the line "Pennsylvania," the largest man-of-war in the navy, if not the world; the stern of the same vessel is seen in Figure Six. At the end of this section (Figure One), is seen the culvert, in the masonry of the Dock, through which the water passes from the chamber of the Dock to the pump-well, as shown in Figures Five, Six, and Seven. The steps, and slides for timber, are also exhibited on Figures One and Seven, at the head of the Dock. At the lower end of Figure One, is the groove in the masonry to receive the stem and keel of the floating gate. Near the stern of the "Pennsylvania," are steps leading from the coping of the Dock, to the broad altar of the chamber, also, the opening or entrance to the draining culvert. The foundation timbers, piling, and concrete, are seen in this, and the other figures, in sections.

FIGURE TWO, is the front elevation of the Dock, on either side of which is seen the openings to the receiving culverts, through which the water passes, from the Bay, to fill the Dock preparatory to taking a vessel out. The same culverts are seen in Figures Three, Four, and Five.

FIGURE THREE, is a section of the Dock where the floating gate is fitted to the masonry, and corresponds to it in shape and dimensions.

FIGURE FOUR, shows, in section, the arch against which the mitre sills and the quoin posts of the turning gates thrust, when the Dock is empty.

FIGURE FIVE, shows, in section, the draining-culvert openings, at the point where the culvert gates, Plate Eight, are placed, to allow the culverts and well to be drained before closing the turning gates.



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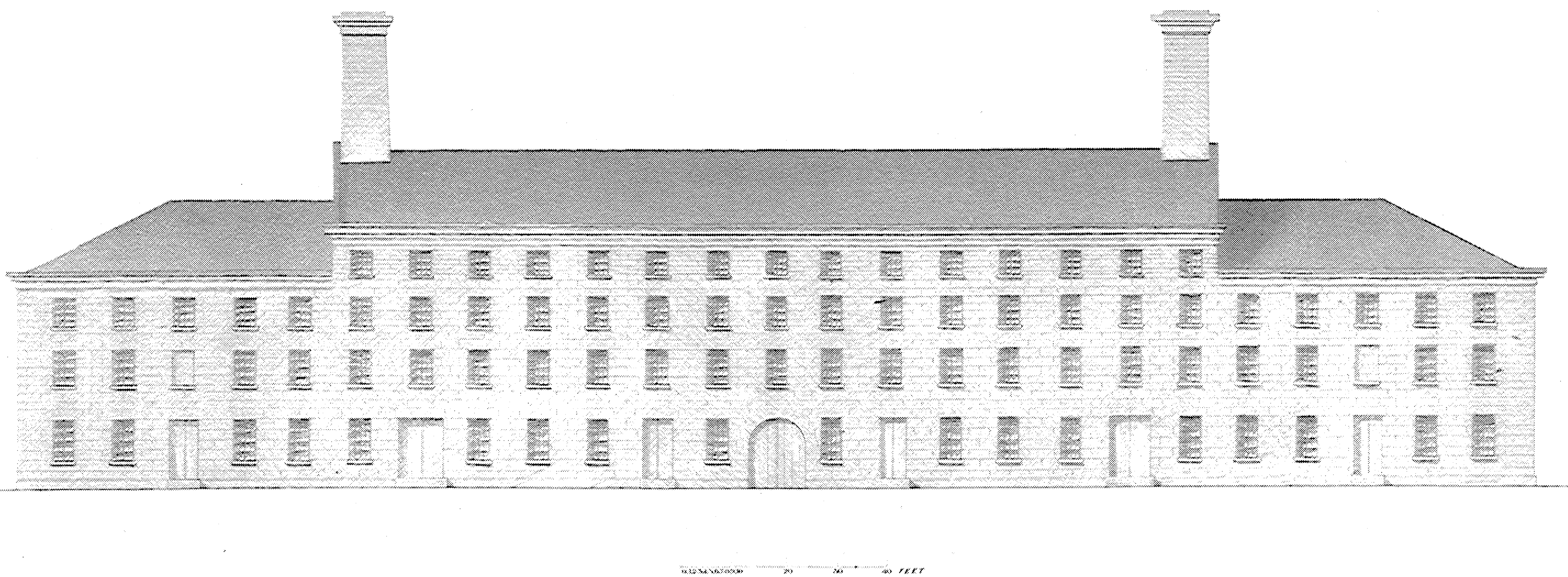
ENGINE HOUSE.

Description of PLATE THREE.

PLATE THREE, shows the elevation of *one* of the fronts of the engine house, three hundred feet in length, with the iron and copper roof over the whole building, the details of which are exhibited in Plate Thirteen.

The right, or east, wing, contains the pumping-engine and pumps, as shown in Plates Ten and Eleven.

ENGINE HOUSE



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FLOATING GATE, OR CAISSON.

Description of PLATE FOUR.

FIGURE ONE, shows an internal elevation of the Caisson, with its general arrangements for operating it; including the capstans, pump-brakes, frame, bulwarks, main-deck, second and third decks, and their supports, stairways leading to them, valve gear, pump chambers and pipes, truss bracing, ribs, angle-irons, knees, stems, and kentlage table and ballast.

FIGURE TWO, shows an external elevation of the Caisson, with the side and stem plates, openings of filling tubes, hawse-holes, ring-bolts, etc.

FIGURE THREE, is a plan of the main-deck, showing the stairways, hatches, check-blocks, position of capstans, and pump-brakes.

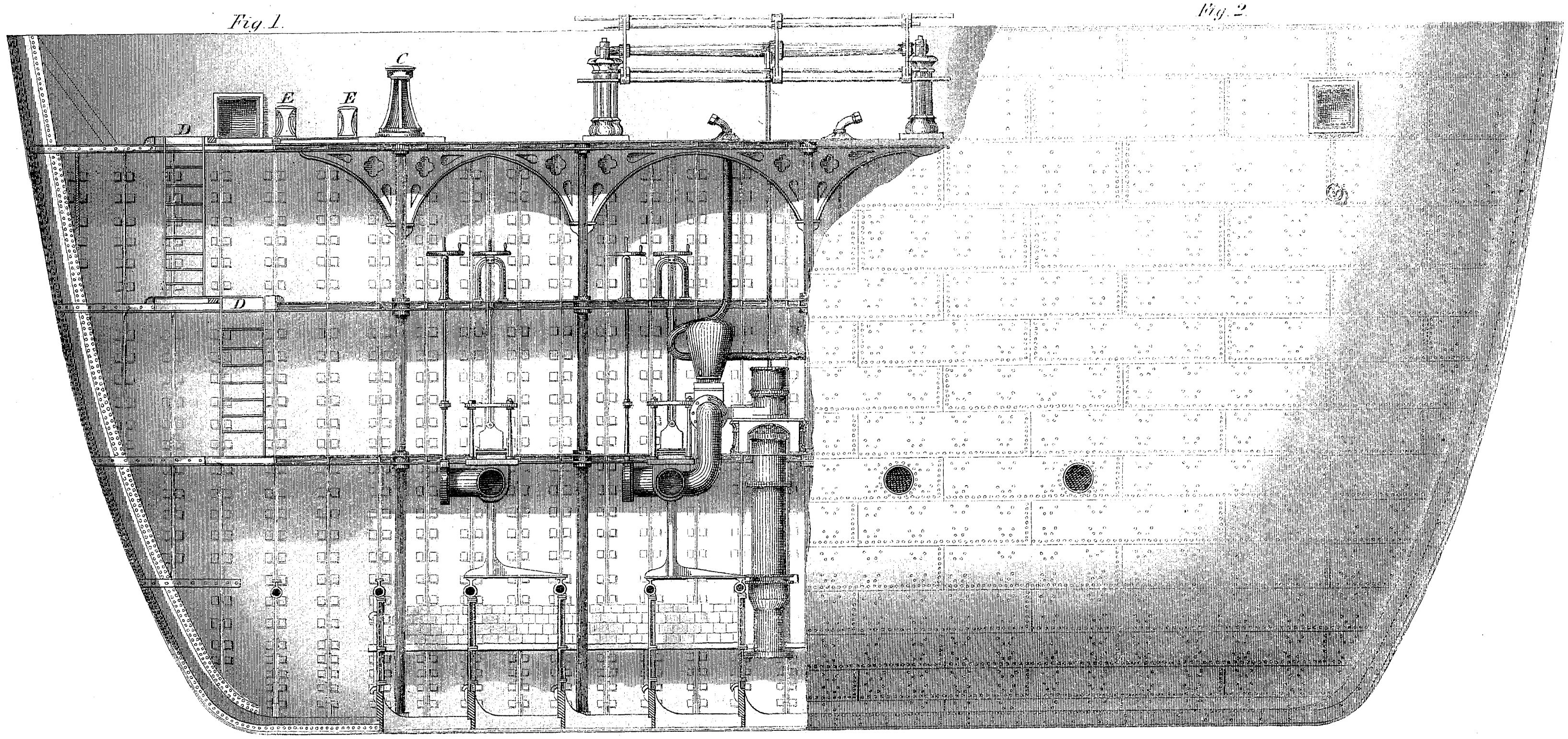
IRON FLOATING GATE

INTERNAL ELEVATION

Fig. 1.

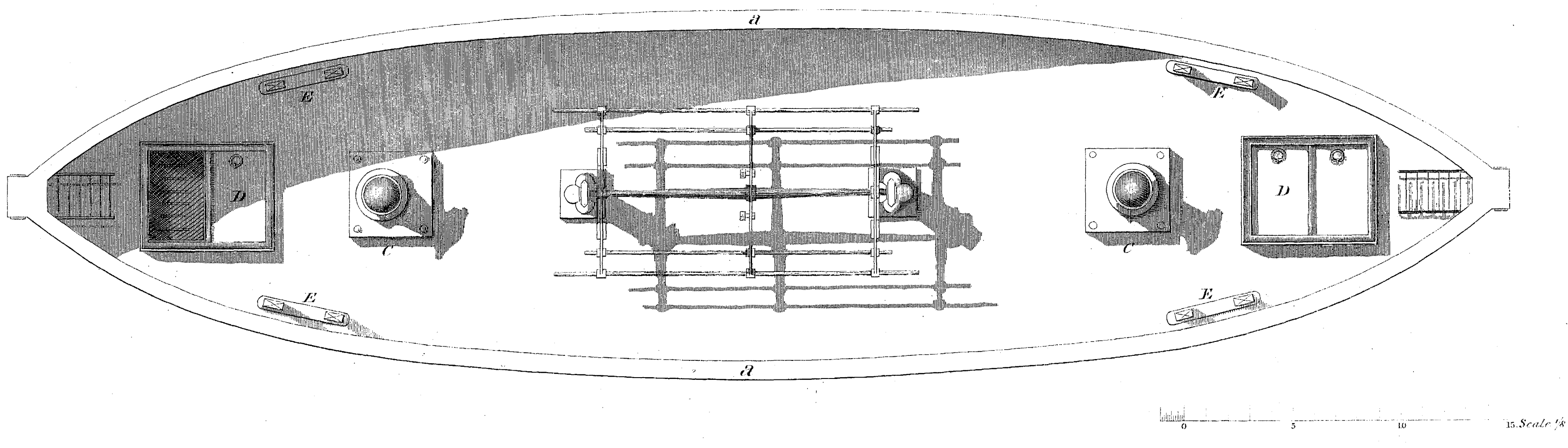
EXTERNAL ELEVATION

Fig. 2



PLAN OF DECK

Fig. 3.



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DETAILS OF IRON FLOATING GATE.

Description of PLATE FIVE.

FIGURE ONE, shows a cross section of the Caisson, with its decks, frame, pumping arrangements, filling tubes, valves and wheels, truss-bracing, and keel.

FIGURE TWO, shows an enlarged view of the truss-bracing, filling tubes, and kentlage table, in plan and section.

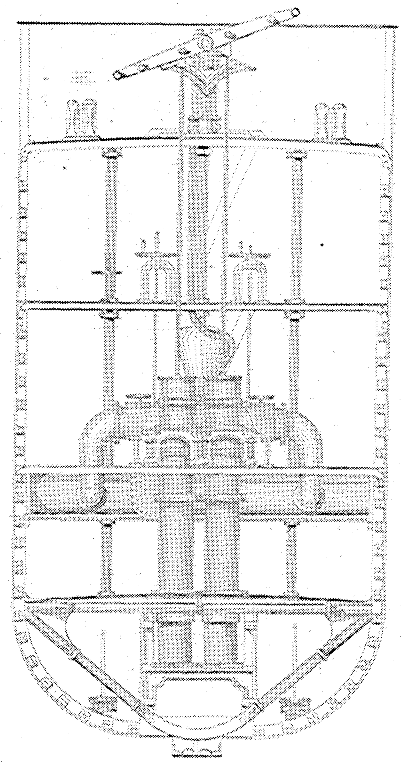
FIGURE THREE, shows a plan of the second deck, with the stations for the ribs of the frame, position of the columns and ties to support the upper deck, and wheels for working the filling tubes' valves; and on the right of this plan is seen the filling tubes on the third deck, the hatchway, transom-plate, and stern.

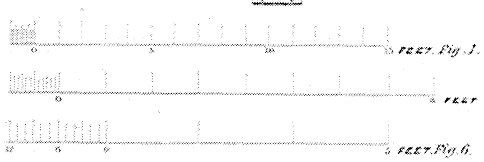
FIGURES FOUR and FIVE, is an enlarged view of the transom-plates, in plan and section.

FIGURE SIX, shows the kingston-valves, and hand-wheel gear for operating them.

SECTION AT CENTRE.

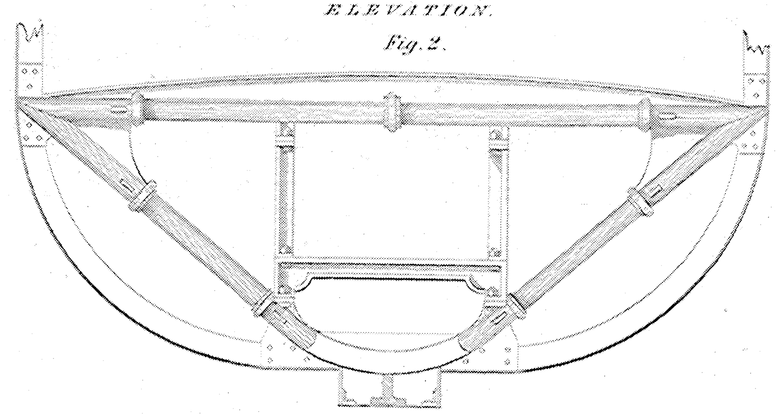
Fig. 1.





ELEVATION.

Fig. 2.



PLAN

Fig. 4.

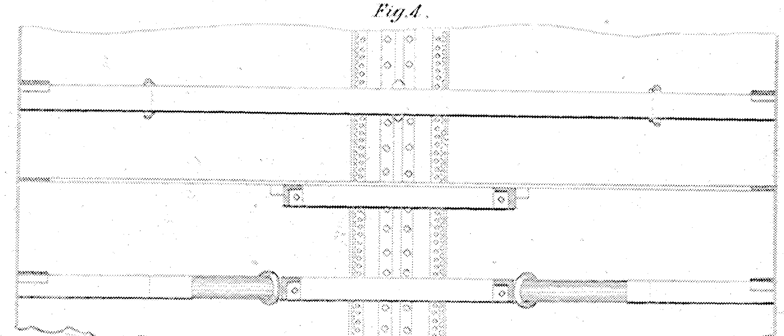


Fig. 7.

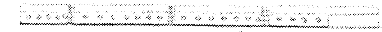
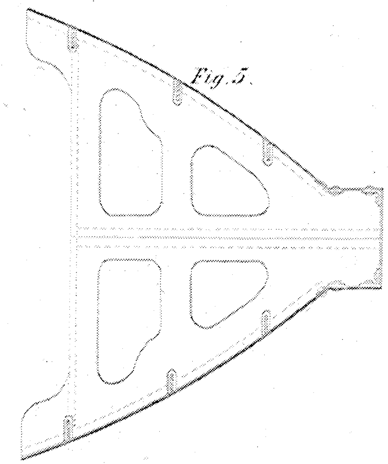


Fig. 5.



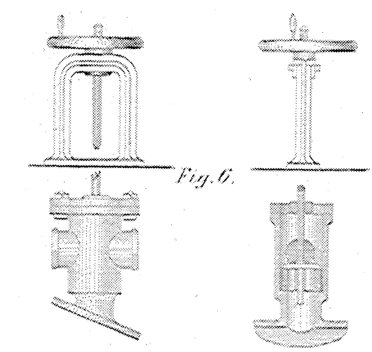
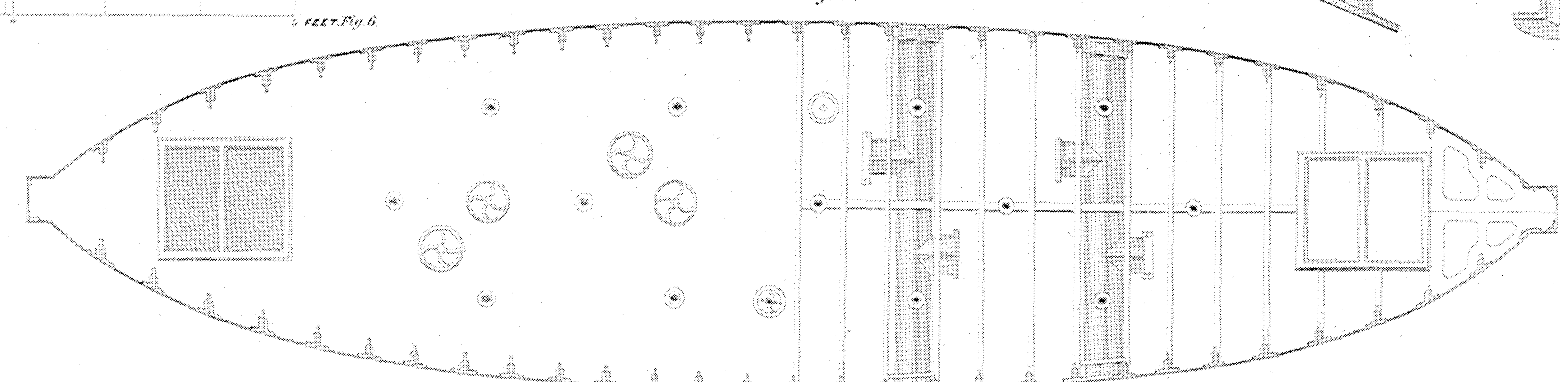


Fig. 6.

PLAN OF IId. DECK.

Fig. 3.



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IRON TURNING GATE.

Description of Plate Six.

Figure One, is a front elevation of the turning gate, showing the hand railing, shafting, racks, gearing, and valves connected with the same.

Figure Two, is an interior elevation, showing the position of the ribs, quoin post, folding leaves, etc.

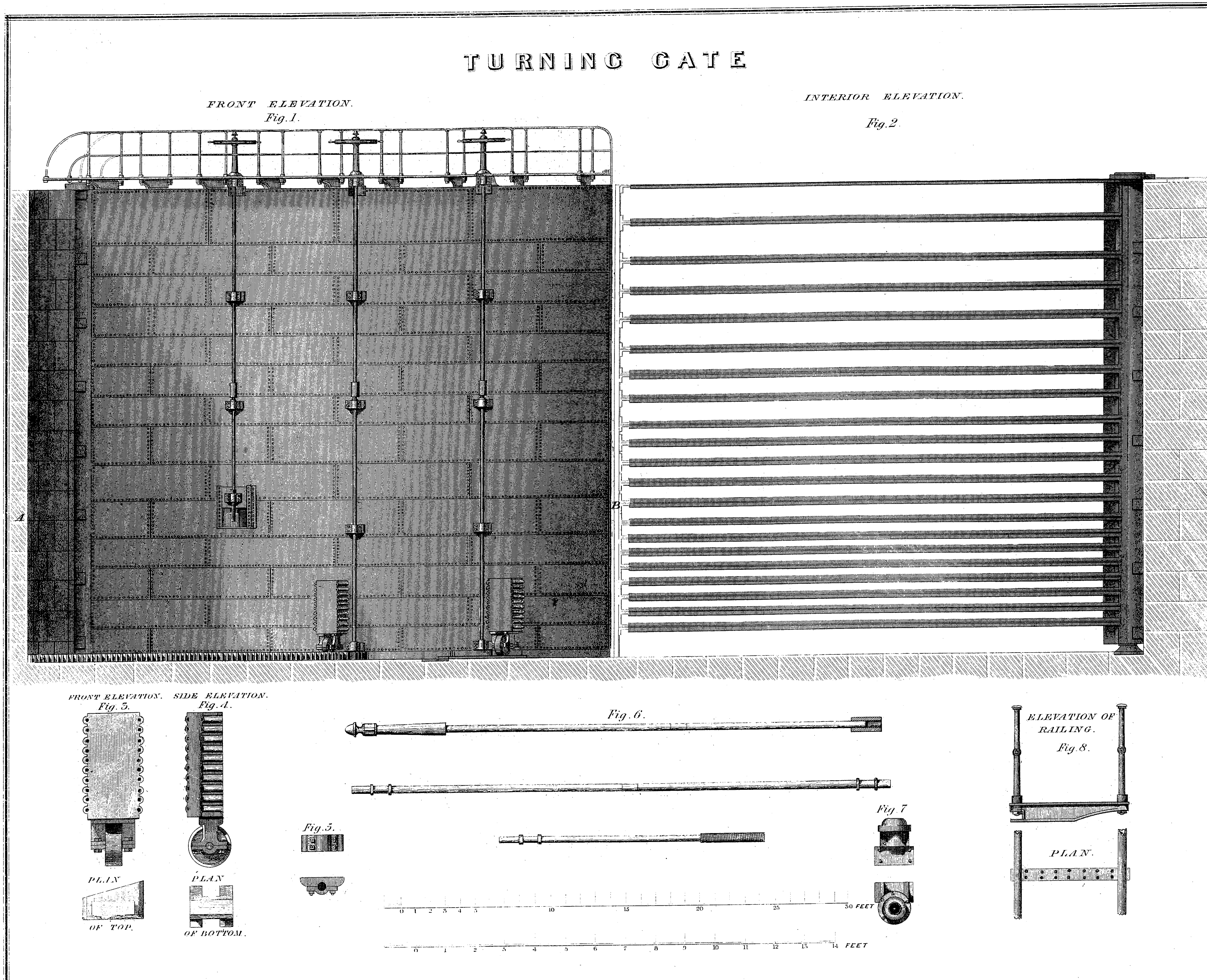
Figures Three and Four, show a front and side elevation, and top and bottom plan of the roller boxes, with friction rollers, on which the gate travels.

Figure Five, is a plan and elevation of the shaft guides.

Figure Six, shows the arrangement of the shafting used for moving the gate and the valves.

Figure Seven, is a plan and elevation of the hollow-shaft bearing.

Figure Eight, is a plan and elevation of the hand railing, and girders of the foot bridge on the top of the gate.



"Stuarts' Naval Dry Docks of the United States.

W. L. Ormsby, New York.

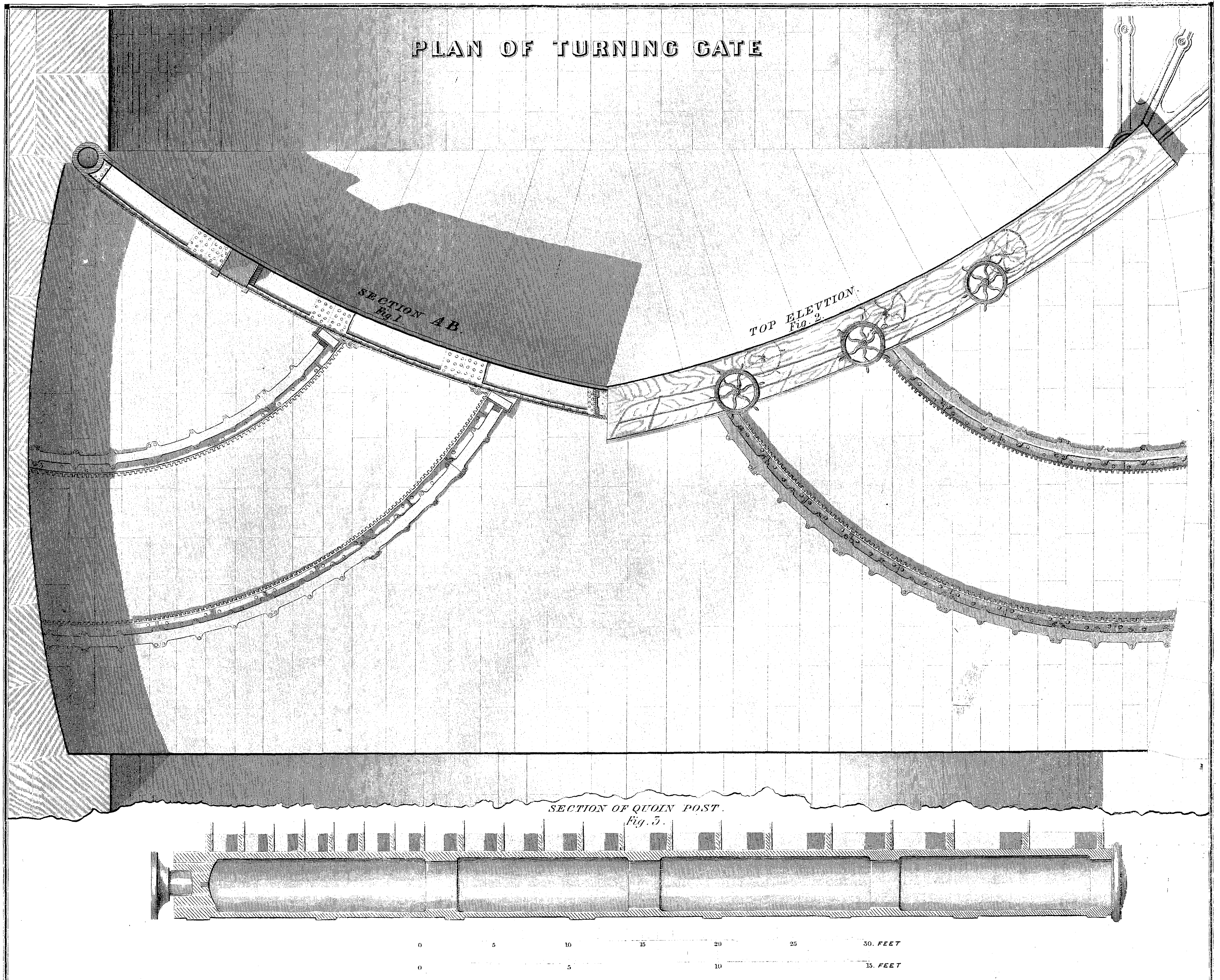
PLAN OF TURNING GATE.

Description of PLATE SEVEN.

FIGURE ONE, is a section of the turning gate, through A, B, on Plate Six, Figure One, showing the valve openings, quoin-post section, rack segments, tram-plates, and the mitre sills of the masonry.

FIGURE TWO, is a top elevation, showing the foot bridge, hand-rail, hand-wheels for moving the valves and gates, and the anchor securing the top of the quoin posts.

FIGURE THREE, is a section of the quoin post, through the centre, showing the thickness of the casting, the head and steps, the internal and external bands, and the outside lugs, to which are bolted the curved bars or ribs of the gate.



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CULVERT GATES.

Description of Plate Eight.

Figure One, is a front elevation of the hand-wheel, hollow shaft, screw shaft and guides. bevel wheels, cast-iron bearings, etc., used in operating these gates within the culverts.

Figure Two, shows a side elevation of the same, with the addition of the horizontal shaft, bevel-wheel gear, chain, and gate.

Figure Three, is an enlarged elevation of the compound gate and seat.

Figure Four, shows the same, in section.

Figures Five and Six, show a section and plan of the seat of the gate.

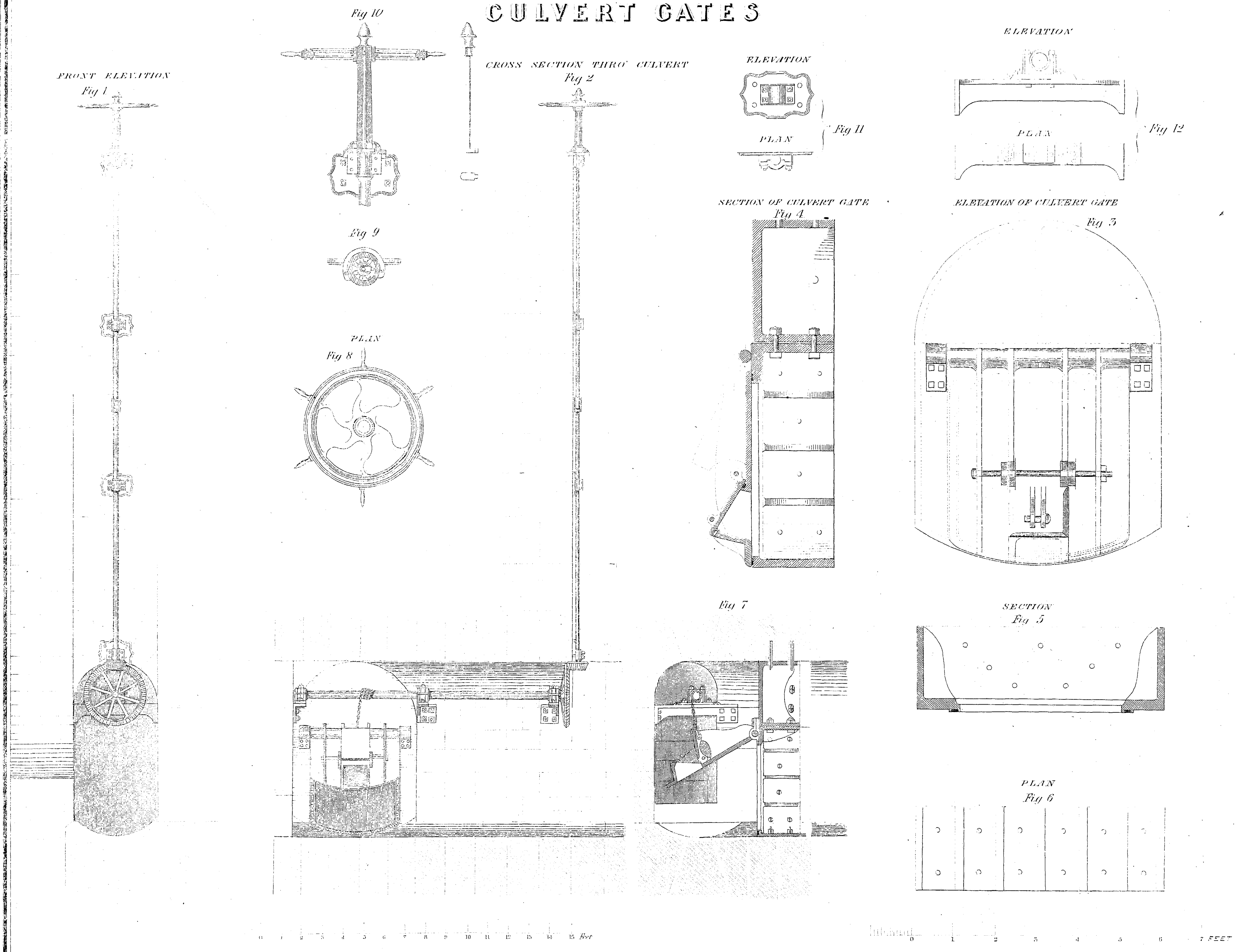
Figure Seven, shows the gate and seat in section, together with the chain, shaft-bearing and pillow block, and the location of the same, in reference to the culvert.

Figures Eight, Nine, and Ten, represent the arrangement of the hollow-shaft, pawl, and hand-wheel.

Figure Eleven, is an elevation and section of the guides to the vertical shaft.

Figure Twelve, shows the cast-iron bearing and pillow block, for the horizontal shaft, in elevation and plan.

CULVERT GATES



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FILLING-CULVERT GATES.

Description of PLATE NINE.

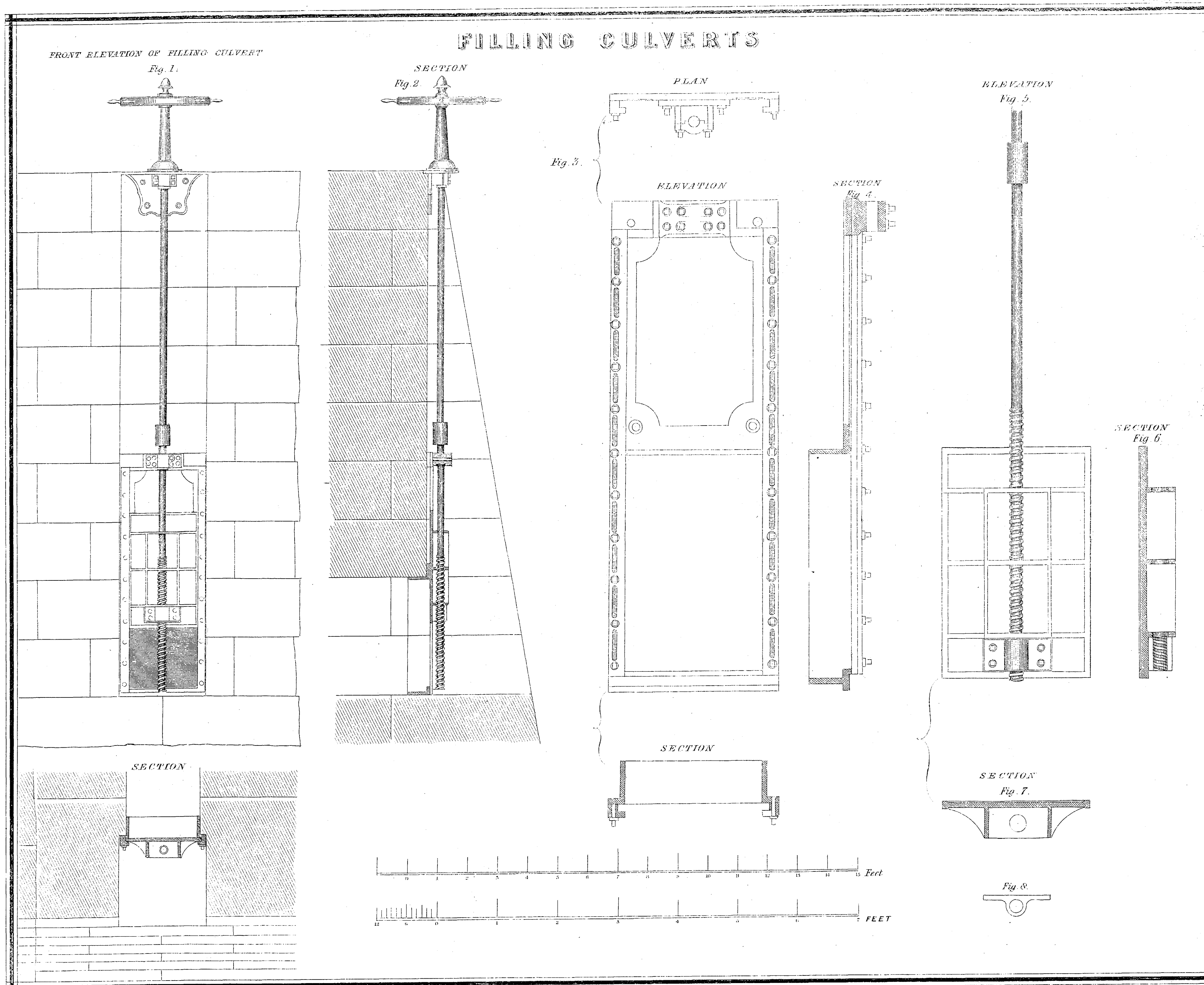
FIGURE ONE, IS a front elevation of the hand-wheel, screw shaft, guides, valve, and slides for opening and shutting the filling culverts.

FIGURE TWO, is a side elevation of the same.

FIGURE THREE, shows a plan of the screw-shaft guide, and elevation of the valve and slide, and a section of the slide and seat.

FIGURE FOUR, is a section of the valve-slide and seat.

FIGURES FIVE, SIX, SEVEN, and EIGHT, show a front and side elevation, and plan in section, of the valve, nut, and screw shaft.



Naval Dry Docks of the United States.

W. L. Ormsby, New York.

PUMPING-ENGINE AND PUMPS.

Description of Plate Ten.

[*See Frontispiece.*]

Plate Ten, shows a side elevation of the engine, and engine frame, and the interior side wall of the engine room: also, the reservoir chamber, with air-pump, condenser, and air-chamber (the two latter in one casting); the pumps, suction pipes, and valves; connecting air-pipe, and columns to support the reservoir and engine bed-plates, the pump covers and connections, the balance-wheel and working-beam and a longitudinal section of the pump-well, with iron flooring over the masonry.

PUMPING-ENGINE AND PUMPS.

Description of PLATE ELEVEN.

[*See Frontispiece.*]

PLATE ELEVEN, shows a front elevation of the engine, and engine frame, in connection with the engine room: also, an elevation of the reservoir chamber, pump and air-pump motion, the pumps with valve seats and guards, iron girders and columns to support the reservoir bed-plate, and a cross section of the pump-well, side steps, iron flooring, and the discharge culvert.

ENGINE BED-PLATE, PUMP, AND CULVERT-GATE DETAILS.

Description of Plate Twelve.

Figure One, is a plan of the pit-work for pumps, showing the arrangement of masonry, the reservoir bed-plate, with openings for pumps, etc.

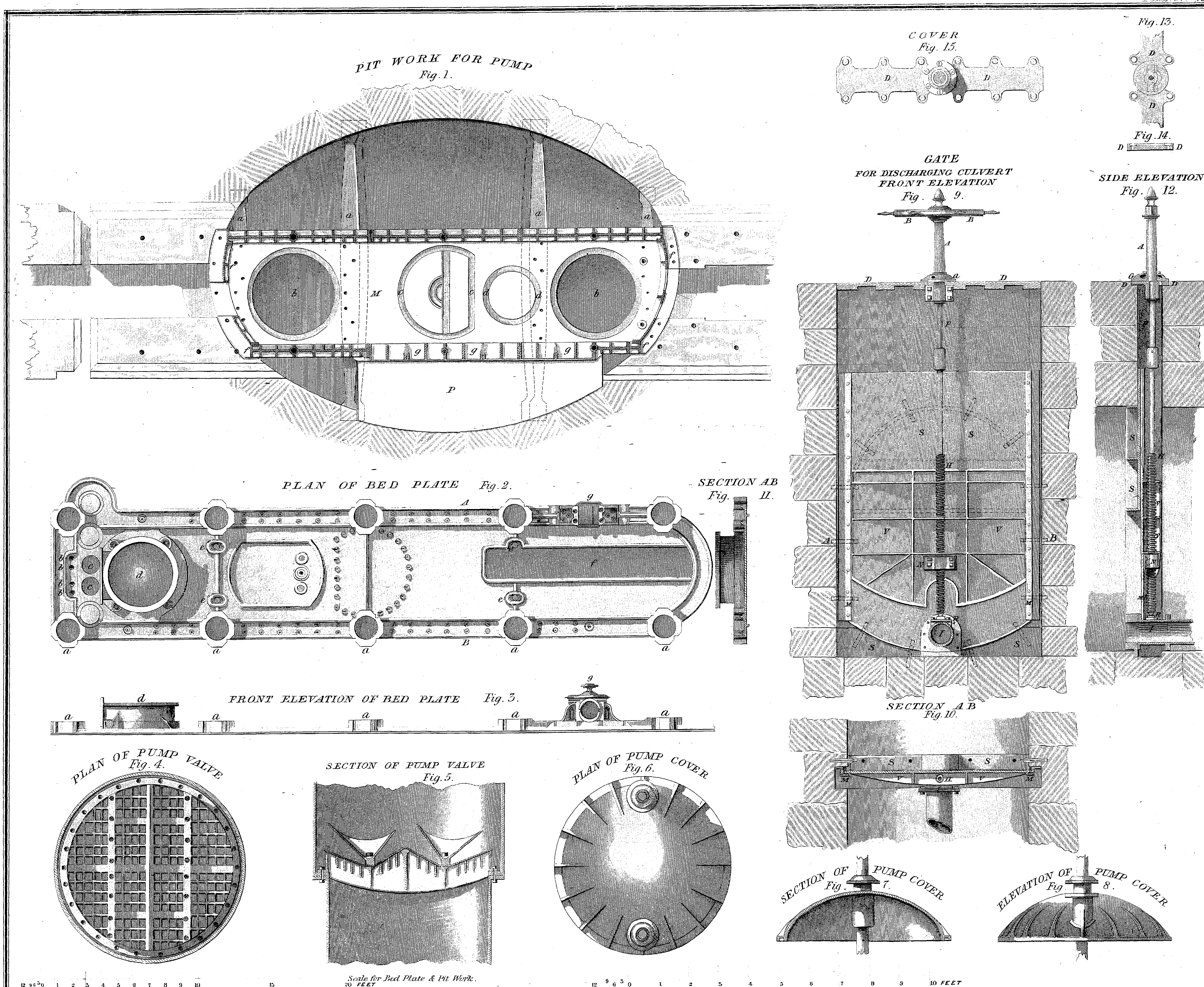
Figures Two, Three, and Eleven, are a plan, elevation, and section of engine bed-plate.

Figures Four and Five, show a plan and section of the pump-valves, with guards and seats.

Figures Six, Seven, and Eight, show a plan, section, and elevation of the pump covers.

Figures Nine, Ten, and Twelve, show front and side elevation, and section of the gate for the discharging culvert.

Figures Thirteen, Fourteen, and Fifteen, show the cover, and the working pawl, in plan and section, of the discharging-culvert gate.



A. Plinta, C.E. "Stuart's Naval Dry Docks of the United States." W. E. Ormsby.

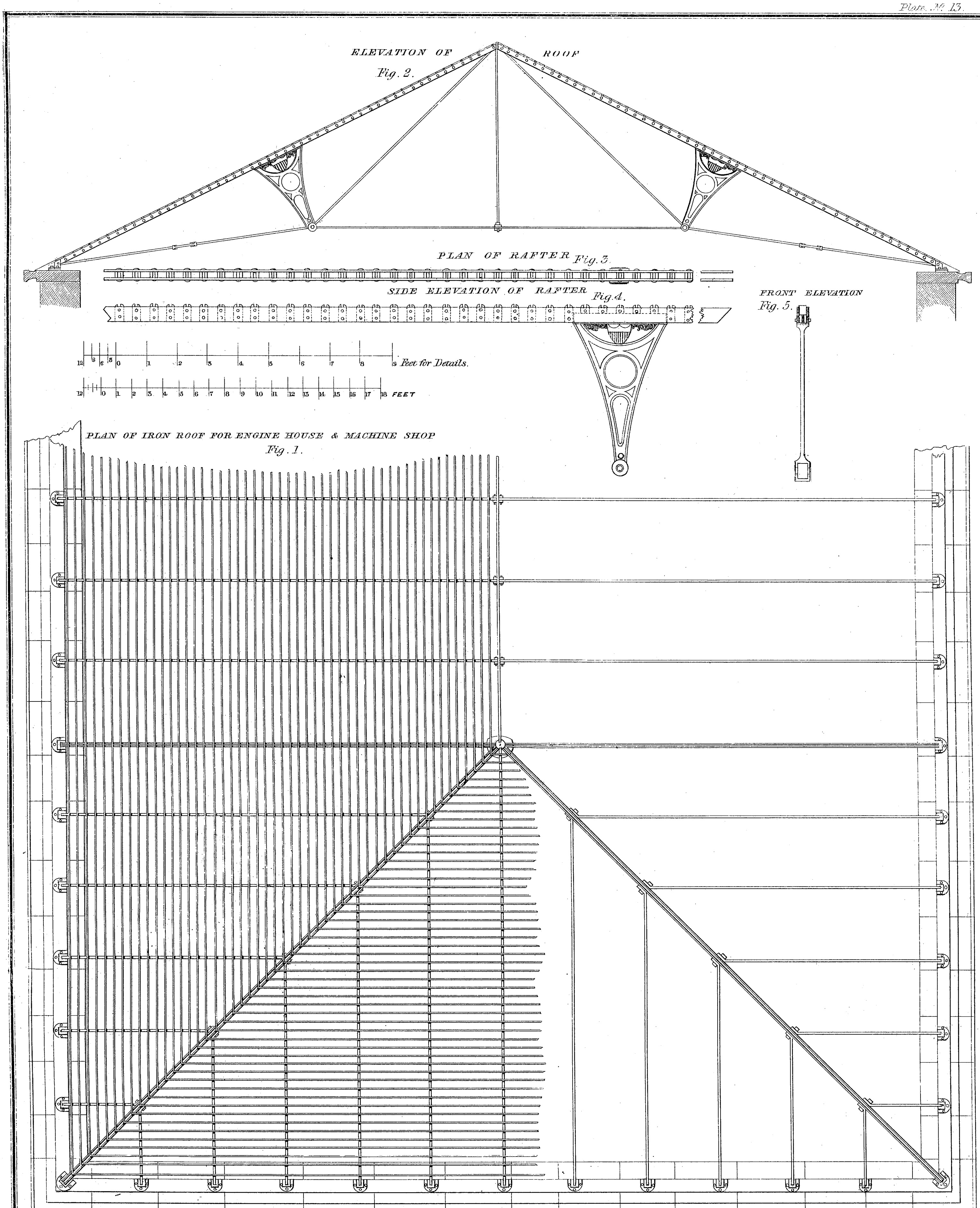
ENGINE-HOUSE ROOF.

Description of PLATE THIRTEEN.

FIGURE ONE, is a plan of the iron roof over the engine room, or east wing of the engine house, showing the principal rafters, with the centre shoe or socket, and the chairs on the walls of the building to secure them, and allow for the contraction and expansion of the iron; also, the secondary rafters, with joints and chairs, and supporting rods for the copper roof-sheets, which are secured to them by copper wires.

FIGURE TWO, is an elevation of roof-truss, with tie-rods, braces, turn buckles, sockets, and chairs.

FIGURES THREE, FOUR, and FIVE, show a plan, side elevation, and section of the rafters and braces enlarged


ELEVATION OF ROOF
Fig. 2.
PLAN OF RAFTER Fig. 3.
SIDE ELEVATION OF RAFTER Fig. 4.
FRONT ELEVATION
Fig. 5.
12 9 6 3 0 1 2 3 4 5 6 7 8 9 Feet for Details.
12 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 FEET
PLAN OF IRON ROOF FOR ENGINE HOUSE & MACHINE SHOP
Fig. 1.

APPENDIX.

APPENDIX.

NOTE A.

DATES.	No. of feet per day.	Cost per day of crank and wheel.	Cost per day of tread-wheel.	Cost per day of steam.	Cost of driving per foot.
		$ c.	$ c.	$ c.	cents.
January 20th, 1845.	33	9.50	–	–	$28\frac{8}{10}$
" " "	50	–	8.50	–	17
" " "	$157\frac{1}{2}$	–	–	15.00	$9\frac{1}{2}$
March 31st, "	142	–	–	14.00	$9\frac{8}{10}$
July 2d, "	260	–	–	14.50	$5\frac{6}{10}$
July 3d, "	309	–	–	14.50	$4\frac{7}{10}$
September 23d, "	915	–	–	22.58	$2\frac{1}{2}$

The time occupied in driving a pile thirty feet into the earth by steam, was one hour and fifty minutes; while to drive a pile of the same dimensions twenty-six feet three inches into the earth, by the tread-wheel, required five hours.

During the month of February and part of March, 1846, there were driven for the Coffer-Dam, one hundred and twenty-two yellow-pine piles, fifteen inches square, averaging forty-one feet long (by steam power), at a cost of $3.70 per pile, or $8\frac{9}{10}$ cents per foot driven in the earth, and $14\frac{9}{10}$ cents per foot of whole length of pile. The cost per lineal foot of Dam, was $3.95. The average depth driven in the earth, was 26 feet; total length driven in earth, was $5.036\frac{1}{2}$ feet.

Three Machines, at work thirty-eight days, making one hundred and forty-six lineal feet of Dam, at the following expense, each, per day.

Labor at Machine.

One Foreman - - - - - - - - -	$1.50
One Brakeman - - - - - - - -	1.25
Seven Laborers - - - - - - - -	7.00
	$9.75
$\frac{1}{8}$ Expense of Engine - - - - -	2.15
Total - - - - - -	$11.90 per day.

Expense of Engine.

One Engineer - - - - - - - - - -	$3.00
One Engine-man - - - - - - - - -	2.00
One Fireman - - - - - - - - - -	1.25
One Laborer - - - - - - - - - -	1.00
Fuel - - - - - - - - - - - - - -	10.00
Total - - - - - - - - - -	$17.25 per day.

Work done by the Engine.

Average $\frac{4}{8}$ Pumps for Temporary Drainage.
" $\frac{1}{8}$ Excavation of Pit.
" $\frac{1}{8}$ each Pile Machine.

Statement of Piles driven by Steam Power, for Coffer-Dam, during the month of September, 1845.

MACHINES.	No. of piles driven.	Size.	Whole length.	Whole distance driven.	Days at work.	Cost per foot of piles.	Cost per foot driven.
		' "	' "	' "		cents.	cents.
Steam Pile 1	36	1.4	1,600.6	515.6	$11\frac{1}{2}$	$8\frac{5}{10}$	$26\frac{5}{10}$
" " 2	12	1.2	482.	185.	3	$7\frac{4}{10}$	$19\frac{3}{10}$
" " 3	16	1.2	627.	271.	7	$13\frac{3}{10}$	$30\frac{7}{10}$
" " 4	52	1.	1,838.	1,312.	14	9	$12\frac{7}{10}$
" " 5	42	1.	1,445.$\frac{1}{2}$	1,271.$\frac{1}{2}$	13	$10\frac{7}{10}$	$12\frac{2}{10}$
" " 6	21	1.	783.	380.$\frac{1}{2}$	$4\frac{1}{2}$	$6\frac{8}{10}$	$12\frac{6}{10}$
" " 7	47	1.2	1,967.	692.	13	$7\frac{9}{12}$	$22\frac{4}{10}$

Cost per day for each machine, $11.90.

The above average is 9 cents per foot for the whole length of pile, 17 cents per foot that is driven in the ground.

Note B.

Dry Dock Office, U. S. Navy Yard, Brooklyn,
July 3d, 1846—10 *o'clock, P. M.*

Sir:

I regret to report, that at a quarter past six o'clock this evening, some thirty feet of the Coffer-Dam was undermined by the pressure of the water from the outside, which found its way *under* the piles, and filled up the Dam in about twenty minutes.

Unfortunately, this accident occurred in that portion of the Dam directly under the engine house, and upon which the engine rested. These piles are supposed to be about forty feet long, and were driven in 1842.

The water found its way under them, and carried out so much of the mud from the bottom, as to cause them to settle down about three feet. It is somewhat remarkable that they have preserved their vertical position, having settled directly down. This probably indicates, that the passage of the water must have been entirely beneath them.

The engine and connecting machinery, appears to be entirely uninjured. The house has settled three feet at one end, and remained nearly or quite in position at the other end. An examination was made yesterday of every portion of the Coffer-Dam, which indicated no movement within thirty feet of where this breach has taken place. For a week past we have been engaged in carting in gravel under and adjoining the engine house and inside of the Dam, for the purpose of strengthening the Dam at the foot. At the sides of the engine house this bank was quite heavy, which has probably saved the Dam from greater damage than has occurred.

The well and pumps appear to be entirely uninjured. We had only a few days since completed a row of piles around them, which has probably saved them from injury.

It will probably be found necessary to remove the engine house back from its present position to a more secure foundation outside of the Dam. It will be necessary to repair the breach by new piles, driven outside of the present Dam.

I have now some fifty men at work opening a communication with the river, to permit the tide to ebb and flow, so as to prevent any further pressure on the weak part of the Dam. I hope to get this passage opened to-night. We have already secured the machinery, which would be likely to receive injury by any further settling of the engine house.

It is impossible now for me to speak of the extent of the damage, or the delay it will cause in the work, with any degree of certainty, but my impression is that the former will not exceed five thousand dollars, and with a strong force the latter will not exceed one month.

The master-workmen, foremen, mechanics, and laborers, deserve great credit for the promptness with which they entered on duty; before eight o'clock we had on a force as large as could work to advantage.

As soon as I can make a more particular examination (by daylight) of the state of the work and the extent of the damage, I will report more fully.

I am, with great respect, your obedient servant,

Wm. J. McALPINE, *Engineer.*

Comm. Joseph Smith,
Chief of Bureau of Yards and Docks.

APPENDIX.

DRY DOCK OFFICE, U. S. NAVY YARD, BROOKLYN,
July 5th, 1846.

SIR:

The works have received no further injury, since the breach of the 3d instant, and every other part of the Dam appears to have remained firm.

It is probable, that with some long piles driven around the outside of the engine house, its foundation can be rendered sufficiently firm to sustain the engine and its boiler in their present location, and avoid the expense of removal as mentioned in my letter of the 3d instant. * * * * *

The breach was evidently made underneath the piles. Soundings outside of the Dam, at the breach, show a depth of thirty-four feet below the top of the Coffer-Dam, and a hard bottom.

The passage under the piles could not have been much lower than this depth; the piles must therefore have been less than forty feet in length, and some of them less than thirty-four feet. The strength of the whaling timbers, probably for some time, held up the piles, until the passage of the water underneath them, extended itself laterally, and brought the whole weight of the engine house upon them, when they sunk suddenly and in their original vertical position.

The soundings now in the Dam, show a less depth than on the outside. When the piles sank, as before suggested, the earth filling in the Dam, at the sides of the breach, probably slid down and filled the breach to the level now indicated by the soundings. The pit was nearly full of water when the engine house and piles fell.

A bulkhead, formed of piles, ran *across* the outside Coffer-Dam.

Several of these piles are now split, and all of them forced from their original position.

It is possible, that the breach was caused by the water from the outside, finding its way by the side of this cross row of piles, to and along the middle row to some pile shorter than the rest, under which it may have found a passage into the second Dam, and thence into the pit. It first burst up at the point marked O, on the sketch, where it encountered the deep piles driven for the well.

On the 3d inst., the excavation for the pit, for about one hundred feet up from the well, was about twenty-eight feet below the top of the Dam, which is several feet higher than had been a fortnight previous, owing to the soft mud flowing down from the upper section of the pit.

The excavation in the old well was about thirty-one feet below the Dam, and in the new well thirty-seven feet below. It is proposed to repair the breach by driving a new row of piles outside of the Dam.

Some expedients have already suggested themselves, to render the outside row of piles, now standing in the breach, serviceable, and save the expense of driving a new row instead of them; but I have not had sufficient time to arrange a satisfactory plan.

All of the work for repairing the breach, will be urged forward with the greatest speed possible, and every exertion will be made to complete it at the earliest moment.

As the work progresses, some expedients will probably suggest themselves, to enable us to recommence pumping the pit out, before all of the work above proposed is entirely completed.

If it is found practicable, and not too expensive, some of the piling machines will be kept at work at night as well as day.

I have not yet been able to make any definite estimate of the cost, or the time required for repairing the breach, but believe that the amount and time stated, in my letter of the 3d, will vary but little from the result, though they are both probably a little too low to restore the work to the same condition it was in before the accident.

I am, with high respect, your obedient servant,

WM. J. MCALPINE, *Engineer.*

COMM. JOSEPH SMITH,
Chief of Bureau of Yards and Docks.

NOTE C.

DRY DOCK OFFICE, U. S. NAVY YARD, BROOKLYN,
September 17th, 1846

SIR:

I regret to say, that another breach in the Coffer-Dam occurred this afternoon. For several days past, springs of fresh water have shown themselves in the bottom of the excavation, near the lower end of the pit; these springs have not been large, and produced no particular uneasiness, until this afternoon, when the quantity of water from them rapidly increased, and about four o'clock began to taste brackish. It shortly afterwards became quite salt, and increased in volume, so much, that I began to apprehend a breach, and immediately directed the pumps to be stopped, and the workmen to gather up their tools and leave the pit. At twenty minutes past four, a large volume of water, mixed with black mud, burst up, nearly on the line of the axis of the Dock, and about seventy feet from the lower end of the Coffer-Dam.

The direction of the current of water was from the corner of the north-west angle and wing of the Coffer-Dam, where it joins the old cob-dock. The pit continued to fill with water, all of which appeared to burst up from the bottom, at the place above designated.

The two outside rows of piles in the north-west corner of the Coffer-Dam, for a distance of forty to fifty feet in length, as well as the third outside row of the north-west wing up to the cob-dock, have settled down from four to five feet. The inside row remained firm for some time, but eventually also settled about one foot for a distance of fifteen to twenty feet.

The water evidently forced a passage under all the piles, except the inside row. I am yet undecided in my own mind, whether it passed under the inside piles, or through their interstices, but am inclined to the opinion, that it found a passage beneath all of the piles. The inside row of piles was driven from ten to fifteen feet deeper than the level of the excavation where the water burst up.

The current of water at the breach rendered it impossible to take the soundings accurately. There appears to be about ten feet greater depth of water than before the breach, on the outside, at the corner of the Dam and cob-dock.

Although the Dam filled slowly, it was impossible to take any measures to prevent the breach, and the force was immediately set at work, to open a passage for the water around the Dam, and prevent the pressure from increasing the extent of the damage.

This passage was opened at half-past five, and by seven o'clock the water in the Dam was within six feet of the height on the outside, and no further damage was apprehended.

A sketch will be immediately prepared, and forwarded to the Department, showing the situation of the breach, and all other particulars, as to the depth of the water and excavations in the vicinity.

The plan proposed, for repairing the breach, will also be forwarded at the same time as the sketch.

A large force was employed at the excavation, but I have given directions to reduce it three fourths, reserving the full force of mechanics, to obtain the greatest dispatch in completing the repairs.

This breach occurred, adjoining to, and a part of, that portion of the Dam which was forced in, on the 2d of February last, and which was then secured by chains.

I am, with great respect, your obedient servant,

WM. J. MCALPINE, *Engineer.*

COMM. JOSEPH SMITH,
Chief of Bureau of Yards and Docks.

DRY DOCK OFFICE, U. S. NAVY YARD, BROOKLYN,
September 21st, 1846.

SIR:

I inclose a sketch, showing the situation of the breach and the works contiguous, before and after its occurrence.

I also inclose a sketch which shows the level, which was reached by the bottom of each row of piles, near the breach; and also a table, copied from the records on file in this office, showing the length of distance driven, number of blows, and distance driven by the last blow, of each pile in the Coffer-Dam, at and contiguous to the breach.

From this table, it appears, that the piles driven in the outside row of the wing of the Dam, were short, and the material into which they were driven was very soft, as is shown by the number of blows given.

There is very little doubt, but this was a very weak part of the Dam, and these short and insufficiently driven piles may have been the primary cause of the breach.

I am yet unable, satisfactorily, to account for the apparent passage of the water under the inner row of piles, which were driven from fifteen to twenty-three feet below the level of the excavation where the water burst up.

These piles have not been disturbed from the line in which they were first driven, but have settled from twelve to seventeen inches.

Several of the piles in the middle row have tipped from two to four feet. In the outside row, the top has been forced over, about the same distance, leaving the bottom apparently nearly in its original position.

If the water forced its passage underneath the deep piles, in the inside row, it indicates a very soft substratum of earth at and below the level of the foundation, and extending under the Coffer-Dam, about in the line of the breach.

The only effectual protection against similar eruptions, is to extend the base of the Dam, and to place sufficient weight of material above it, to resist the percolation of water, through the substratum referred to.

It was chiefly with this view, that the line proposed for the outside piling, to be driven to repair the breach, was laid at so great a distance from the original Dam.

The point of its termination, at the old cob-dock, was in some degree determined by it being the most feasible point to break through the old dock, so as to carry a tight connection of earth from the Coffer-Dam to the main shore.

From a careful examination of this old dock, there appears to be a division between the foundation cribs, very near the point assumed as the line for the new piles.

This dock is about twenty-five feet deep, and is composed of round timbers bolted together and filled with stone. Its removal will necessarily be tedious, and attended with many difficulties, but the advantage that will be gained by breaking through it, will repay its cost and trouble.

It is yet impossible to form an estimate of the expense or the delay that will be caused by the breach, but I have strong hopes that the former will not exceed ten or twelve thousand dollars, and the latter six or eight weeks.

It has occurred to me, that there was a possibility that the old Dam could be repaired and strengthened, so as to take the water down low enough, to allow some excavation to be taken out at the head of the pit, before the breach is permanently repaired. The location of the new engine and pumps, near the head of the pit, will enable it to be drained for this purpose.

I propose trying, with caution, how far the project is feasible.

I am, with great respect, your obedient servant,

WM. J. MCALPINE, *Engineer.*

COMM. JOSEPH SMITH,
Chief of Bureau of Yards and Docks.

NOTE D.

The following extract is taken from the contract for the granite facing:—

"All of the stone must be of the most durable description of granite, entirely free from sap, stains, or seams, and obtained from quarries which may be approved of by the engineer in charge of the work; all of the stone which show in the chamber must be of the same color and general appearance.

"Patterns for quarrying and cutting the stone will be furnished by the Government; on all the arch-stones full corners and edges will be required on the back lines of the stone; all of the stone will be delivered cut, except such stone as may be directed to be delivered unwrought, in which case they shall be quarried out without any unnecessary excess of stone, but of sufficient size to fill the patterns. The cut stone designed for the facing of the work, must be delivered with perfect edges on the show-lines, and none will be received which are in any way marred or nicked.

"The stone must be delivered in the order in which they are required for use, as far as practicable.

"In the courses of the chamber above the inverted arch, and in the other walls where an additional width of bed is permitted, the minimum size will be given in the bills, but stone of greater width will be received.

"Suitable 'lewis' holes shall be drilled in the bed, or such other surface as may be directed, to receive a lewis of sufficient size to suspend the stone with safety.

"Such cranes, machinery, and assistance as may be required for discharging the stone from the vessels at the Navy Yard, will be furnished by the Government.

"The cutting which is required to be done on the face of the stone which shows, and also on the builds of the outer stone, shall be, as hereinafter described as first-class work; that required on the beds, builds, and joints, shall be, as hereinafter described as second-class work; that required on the rear of the front and interior stone, shall be, as hereinafter described as third-class work. The beds and joints must be dressed up full to the square, and no slack joints will, in any case be permitted. The cutting will be required to be done in the following manner, to wit:—

"*First-class work.*—The arris must be kept clean and sharp, with fine-cut drafts run around the surfaces to be dressed; within these lines the surfaces must be taken down fair and even, with a patent hammer of eight plates; no holes or depressions of any kind that will show in the face will be permitted; and the dressing with the hammer must be level and square, so as to present a smooth, fair appearance.

"*Second-class work.*—A good arris must be kept; clean draft lines must be run around the surface to be dressed; within these lines the stone must be dressed down to a fair, even, level surface, with a common pean hammer. No depressions of any kind will be allowed within six inches of the face; none which exceed six inches in diameter, or one inch in depth, or when they shall together exceed one fourth of the surface in which they occur

"*Third-class work.*—Draft lines shall be run around the surface to be dressed; within these lines, they shall be pointed down to a fair even surface and finished with a pean hammer, so as to make good close work of not exceeding half inch joint; no cavities or depressions will be allowed which exceed eight inches in diameter, or one and one half inches in depth, or when they shall together exceed one fourth of the surface in which they occur."

The following extract is taken from the contract for the backing stone:—

"They shall be of a sound durable description of granite or gneiss, free from sap or seams, split out by wedges in blocks, with parallel beds and sides; at least three fourths of the bed, and one half of the build, must have a fair level bearing-surface; the vertical joints must be split down at right angles to the bearing-surface of the stone; the stone must all be drilled on the top bed, to receive a lewis of such size and form as shall be directed; the dimensions of the stone must in no case be less than the following, viz.: length, two and one half feet; width, one and one half feet; thickness, eight inches; and no stone larger than the following will be received, viz.: length, eight feet; width, four feet; thickness, two feet; and the stone must average not less than twelve cubic feet."

The prices which have been paid for stone used in this work are as follows:—

The granite for the foundation courses of the Dock, and for the rear courses of arches and side walls, six dollars and seventy-five cents per cubic yard; and for hammering, or scabbling the same, ten cents per superficial foot; the flooring of the Dock, fifteen dollars per cubic yard; and for cutting the face, thirty-five cents per superficial foot; and for the beds, builds, and joints, seventeen cents per superficial foot.

The rubble stone for backing of the lower courses of the Dock, five dollars and ten cents per cubic yard for first quality, and three dollars and ninety-four cents for the second quality, for backing the culverts.

The plain ashler, and straight and square stone (altar), ten dollars per cubic yard; and for the first-class fine cutting on the same, forty cents, and for the second-class, twenty cents, per superficial foot.

The checked, bevelled, curved, and arched stone, at the rate of fifteen dollars per cubic yard; and for the first-class of fine cutting on the same, at the rate of one dollar, per superficial foot; and the second-class cutting, twenty cents.

The coping stone, twenty dollars per cubic yard; and the fine cutting, for top and face, sixty cents, and for the beds and builds, twenty cents, per superficial foot.

The interior stone, above the floor, nine dollars and fifty cents per cubic yard; and for cutting, third-class, sixteen cents per superficial foot.

The granite for the engine house was furnished, on an average, of about ten dollars per cubic yard, for the face work, and the foundation and interior, for five dollars per cubic yard. The cutting was done in part by the contractor, for forty cents per superficial foot of ashler, and sixty cents for the water table, door and window lintels and sills, and the cornice. The other portion was cut by Government cutters at the same prices.

NOTE E.

On the 25th of May, 1850, the chief of the Bureau of Yards and Docks appointed a commission of engineers, consisting of Wm. P. S. Sanger, Charles B. Stuart, Charles W. Copeland, and Wm. M. Ellis, to examine and report the alterations and additions that had been made to the pumping-engine and pumps, under the approval of Mr. Copeland, who was appointed by the Bureau inspecting engineer, if the alterations and additions made were advantageous, and proper, and what further alterations, if any, they would recommend, and the cost of the same.

The board approved of the alterations and additions made to the engine and pumps (which are noted in the description of the engine and pumps, pages 50 and 51), and further reported, that, "although the board are agreed in the opinion that the changes made are advantageous and proper, still we do not intend to convey the idea that the work is now beyond the reach of danger, but are of opinion that still further changes may be made, which will also be advantageous and proper. The board are unanimous in the opinion, that if the centre support be taken from the branch-pipes, and a cast-iron plate be laid down, covering a large portion of the bottom floor (of the well), and upon this a short column be placed under the branch-pipes, and four columns under the principal beams of the reservoir, the chances of security will be much enhanced. This addition will probably cost $3,000. We would also recommend that bottoms be put in the rose-pipes, and that a strainer of copper-wire, with half-inch meshes, be placed in the discharging culvert, which will probably cost the further sum of $500. In consequence of the failure to sink the well to the depth originally contemplated, it will become necessary to close a part of the openings in the rose-pipes, to enable the engine and pumps to draw the water from the floor of the chamber. We do not consider the reservoir as a portion of the pumps or engine, and therefore it is not part of the contract. It is, in fact, a part of the well, was ordered by the late engineer (to be furnished by the contractor for the engine and pumps), and should be paid for as an open purchase."

APPENDIX.

Note F.

Correspondence relative to Plans for the Machinery to open and shut the Iron Turning Gates of the Dry Dock.

Dry Dock Office, U. S. Navy Yard, Brooklyn,
June 28th, 1850.

Sir:

I herewith inclose copies of a letter to Horatio Dixon, Inspector of the Iron Gates for this work (constructing under your contract), and his reply, together with drawings relative to a proposed change of plan for the opening and shutting of the folding gates, and the passage of water through them.

As the terms of your contract allow (by mutual agreement of yourself and the Government), any change of plan, which shall be advantageous to the work, and knowing that your skill and experience would enable you to form a correct opinion upon the merits of the proposed change, I shall be pleased to have you, at your earliest convenience, examine the inclosed letters and plans, and give me, in writing, your views thereon.

Please return the drawings, as I have not time to make copies.

Very respectfully, your obedient servant,

CHARLES B. STUART, *Engineer.*

Henry R. Dunham, Esq.
Contractor for Iron Gates, New York.

Sir:

Your favor of the 28th of June, inclosing a drawing of a proposed change of the plan of opening and shutting the folding gates of the Dry Dock, together with a copy of the correspondence between yourself and Mr. Dixon upon that subject, and requesting my views and opinions in regard thereto, was duly received. After as careful an examination of the matter as I have had time and opportunity to bestow, I have no hesitation in saying, that the proposed change is judicious, and think the same an improvement in opening and shutting the gates far superior to any thing of the kind ever adopted, and one that will materially diminish the cost of construction.

I cannot, however, concur with Mr. Dixon in the amount of the saving to the Government by this important improvement, estimated by him to be but thirty-five hundred dollars ($3,500). From a practical examination and comparison of the cost of the work under the contract plan, and of that now proposed, I am quite certain that the difference in favor of the latter would be at least six thousand, five hundred dollars ($6,500).

I would consent, however, to meet the wishes of the Department in regard to the contemplated change, provided I shall be allowed the sum of three thousand, five hundred dollars ($3,500), being the amount Mr. Dixon estimates would be saved to the Government by the change, and to be allowed for work done for the change the price named in my contract for "other work." I estimate the Government would save, in addition to the above, at least three thousand dollars more, and have a pair of gates far superior in their operation to any thing of the kind ever constructed.

Very respectfully, yours,

H. R. DUNHAM.

CHAS. B. STUART, ESQ.
Chief Engineer of U. S. Dry Dock.

NEW YORK, *October 8th*, 1850.

SIR:

Herewith I have the pleasure of handing you estimates for opening and shutting the folding gates, on your newly invented plan.

In presenting this estimate, agreeable to yours, inquiring "what would be the cost of the machinery we estimated upon, at the time of contracting for the iron gates;" I respectfully submit the following:—

When examining the plans for the gates, I was shown the drawings for the capstans, and for gearing for opening and shutting them. The barrel was necessarily very heavy, with a screw cut thereon, with a pitch corresponding to the distance of the chain-links, vertically measured, when coiled on the barrel of the capstan. The shaft on which this capstan revolved, had a corresponding screw, or thread, cut thereon, and was sufficiently long, to take the capstans and project each end, to allow the elevation and depression of the same, to wind up and contain the chain for opening and shutting the gates.

The object of this arrangement, being to preserve the parallelism of the chains with the bottom of the gates, through the entire range of motion in closing and opening them, the shafts on which these capstans revolved, would, necessarily, from their length and distance between points of support (when considered as a screw, on which to allow the capstans to work, must be mathematically straight and true, at all times), require to be about nine inches diameter, and, of course, would be extremely heavy and expensive.

On these capstans was placed a heavy spur wheel, which was worked by a pinion on a feathered shaft, said shaft extending upwards through the masonry of the Dock, above the coping, with a capstan head, in which to place levers to give it motion. The cost of all complete, including chains, clevis's, hawse-hole casting for face of Dock, we estimated between fifteen and sixteen thousand dollars, delivered agreeably to the terms named in our contract.

The last plan, and the one submitted by you for my consideration, left by the late Engineer, as original, is a simple plain capstan with a fixed barrel, which would not answer at all, because the very first revolution

would create an angle in the chain, quite fatal to its further use, because of the immense friction against the quoin-post journals, and in the capstan itself.

Your invention is the only one applicable and proper, to be used for the purpose, and if executed with due consideration to its importance, will (at my constant prices) cost as follows:—

16 Plate Segments	$1,440.00
Pitching and trimming Teeth	1,000.00
Fitting up, and cutting do.	1,200.00
4 wrought-iron Pinions	800.00
4 Welded Shafts for do.	1,312.50
Turned Surfaces	1,500.00
Fitting and putting up 24 Bearings	720.00
24 Bearings cast	576.00
4 Bases turned and fitted	120.00
4 Head Hand Wheels finished	600.00
Bolts and Nuts complete	400.00
Total, as above,	$9,668.50

I am willing to execute the work, for the above sum, and agree to the change in my contract, by the substitution of the above, for the opening and shutting of the turning gates.

Respectfully,

HENRY R. DUNHAM.

CHAS. B. STUART, ESQ.,
Chief Engineer of U. S. Dry Dock.

DRY DOCK OFFICE, U. S. NAVY YARD, BROOKLYN,
October 10*th*, 1850.

SIR:

Referring to your letter of the 23d of last August, relative to arranging with Mr. Dunham under his contract for the necessary machinery for moving the folding gates as per plan submitted by me, I now inclose a proposition from him for your consideration.

It will be seen that Mr. Dunham refers to a plan submitted to him by the late engineer (Mr. McAlpine), at the time he put in his proposal for the building of the gates, and which it was estimated to cost from fifteen to sixteen thousand dollars at his prices, as proposed—

* * * * * *

On inquiring of Horatio Dixon, the machinist on this work, I learned that he did, last year, at the request of the engineer, *design,* and *draw out a plan* for the opening and shutting of the folding gates, similar to the

one described by Mr. Dunham in the inclosed letter, and which Mr. Dixon estimated to cost about the sum there named, exclusive of an expenditure of from four to five thousand, to fit the work to the masonry of the Dock, making the whole cost about twenty thousand dollars.

* * * * * *

The plan thus made, Mr. Dixon informs me, was taken away by the late engineer (with other drawings) last fall, and no copy left, to his knowledge.

Upon examining the plan left in this office, it was seen, that it was entirely *impracticable* for the purpose intended, and therefore its construction would be useless. I at once suggested the plan, submitted to the Bureau last August, and directed Mr. Dixon to draw out the *details,* which he has done with his usual skill and judgment, and now estimates the cost at less than *half* that of the original plan, and the machinery much superior, and altogether more simple, and better adapted, in every particular, to accomplish the desired result; in this opinion it will be seen Mr. Dunham fully concurs.

Mr. Dixon estimates for the machinery on the plan recommended to the Bureau, at the contract prices for "other work" in Mr. Dunham's contract, $7,141.98, and twelve per cent. for contingencies, would amount to $8,856.17, to which is to be added from twelve to fifteen hundred dollars, to fit the work to the masonry. This estimate, it will be seen, is less than the proposition of Mr. Dunham (by $812.43), which I suppose is to be accounted for by the addition of percentage for contingencies, and for prospective profits upon the *larger* amount of work included in the original or contract plan.

By reference to Mr. Dunham's contract, it will be seen that, "if in the course of construction any improvements or alterations to the advantage of the United States suggest themselves to either party, upon mutual agreement they may be adopted," which gives the Bureau the power to sanction the proposed alterations, if deemed to be for the advantage of the Government, if done at the cost named by Mr. Dunham; and although I have great confidence in the reliability of the estimate made by Mr. Dixon, and think it would cover the cost of the work, yet I cannot for a moment doubt that if Mr. Dunham could *not* reduce his price to that estimate, that the advantage derived by the Government by the change, would be greatly beyond the sum in question, not only in the construction of the work, but in working the machinery for all time to come. The early answer of the Bureau is requested, it being important to have the patterns made at the earliest possible moment, to allow the contractor to complete the gates this year.

* * * * * *

I am, with respect, your obedient servant,

CHARLES B. STUART, *Engineer.*

COMM. JOSEPH SMITH,
Chief of Bureau of Yards and Docks.

APPENDIX.

DRY DOCK OFFICE, U. S. NAVY YARD, BROOKLYN,
November 11*th*, 1850.

SIR:

Having received instructions and authority, on the 21st ult., from the Bureau of Yards and Docks, to accept of your proposition of the 8th of October last, consenting to a change in your contract for the machinery necessary to shut and open the folding gates, and to furnish all the materials, and do all the work necessary to complete the fixtures according to the plan and drawing submitted by me to you, and presented to the Bureau, and which are referred to in your communication of the 8th ult., for the sum of nine thousand, six hundred and sixty-eight dollars and fifty cents, which sum is to cover a guarantee that the materials and workmanship are to be of the *very best quality* for the purpose intended, and to insure the working of the same in a satisfactory and proper manner, the patterns being furnished by the Government according to the plans already referred to. I hereby notify you of my acceptance on the part of the Government of your proposition, with the understanding that the sum herein named will be paid you as soon as the machinery shall be constructed and put in successful operation in opening and shutting the iron folding gates, which are embraced in your contract of August 16th, 1849.

Your acceptance of this in writing, will be considered a contract on your part for constructing and insuring the working of the machinery referred to in this letter.

Very respectfully, your obedient servant,

CHARLES B. STUART, *Engineer.*

HENRY R. DUNHAM, ESQ.,
Contractor for Iron Gates, New York.

NEW YORK, *November* 11*th*, 1850.

SIR:

I have received yours of this date, relative to machinery for opening and shutting the folding gates for the U. S. Dry Dock, and accept the same; and am willing to proceed in its construction under the conditions you are pleased therein to express, the sum for the same being, as you have named, nine thousand, six hundred and sixty-eight dollars and fifty cents.

Very respectfully, yours,

HENRY R. DUNHAM, *Contractor.*

CHAS. B. STUART, ESQ.,
Chief Engineer of U S. Dry Dock

Note G.

Contract Prices for Iron Gates.

FOR THE TURNING GATES.

The Wrought Iron, per pound	15¼	cents.
The Cast Iron, "	2	"
The Composition Metal, "	28	"
The Steel, "	50	"
The India-Rubber, "	100	"
The Paint, "	10	"
The Timber, per superficial foot	20	"
The Planing, Boring, Turning, Chipping, and Drilling, per superficial inch	2	"
The Welding of Wrought Iron, per pound	2	"

FOR THE FLOATING GATE.

The Wrought Iron, per pound	12½	cents.
The Cast Iron, "	8	"
The Composition Metal, "	30	"
The Copper, "	50	"
The Paint, "	12½	"
The India-Rubber, "	100	"
The Chipping, Boring, Filing, and Planing, per superficial inch	2	"
The Welding of Wrought Iron, per pound	10	"
The Iron Kentlage, for ballast, "	4	"

Note H.

Contract Prices for Pumping-Engine and Pumps.

FOR THE ENGINE AND BOILERS.

For Engine and Boilers complete, according to contract and specifications, $37,300

FOR THE PUMPS, RESERVOIR, ETC.

For Cast Iron, per pound	8	cents.
For Wrought Iron, "	18	"
For Copper, "	45	"
For Composition, "	34	"
For India-Rubber, "	65	"
For Planing, Boring, Chipping, etc., per superficial inch	2	"

The price for the engine, includes the painting, and bronzing, and all the work of setting up ready for use, the Government preparing the masonry connected with it.

Note I.

Expenditures for Labor for the Construction of the U. S. Dry Dock, at the Navy Yard, Brooklyn, New York, from its commencement, October 22d, 1841, showing the Total Amount each fiscal year, to 31st of August, 1851.

CLASSIFICATION.	From Oct., 1841, to Aug., 1842.	From 12th Oct., 1844, to 30th Sept., 1845.	From 1st Oct., 1845, to 30th Sept., 1846.	From 1st Oct., 1846, to 30th Sept., 1847.	From 1st Oct., 1847, to 30th Sept., 1848.	From 1st Oct., 1848, to 30th Sept., 1849.	From 1st Oct., 1849, to 30th Sept., 1850.	From 1st Oct., 1850, to 31st Aug., 1851.	TOTAL.
	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.
Offices - - - - - -	1,070.99	8,510.72	9,523.58	6,679.52	6,180.72	6,386.04	5,783.07	3,846.70	47,981.34
Tools and Fixtures - -	38.50	488.63	4,570.18	1,549.08	1,276.83	5,140.96	2,670.28	1,336.66	17,071.12
Temporary Drainage - -	–	3,673.57	10,941.89	18,670.90	4,273.19	925.98	883.23	–	39,368.76
Temporary Wharf - - -	1,420.68	58.50	–	–	–	–	–	–	1,479.18
Steam-Engines - - - -	–	–	–	–	2,029.35	1,928.59	2,601.11	–	6,559.05
Coffer-Dam - - - - -	1,590.87	31,468.19	44,760.43	20,639.00	435.75	35.50	–	–	98,929.74
Sheet Piling - - - -	334.81	8,455.39	5,953.53	–	–	–	–	–	14,743.73
Excavation - - - -	53.72	39,461.28	20,993.23	47,836.97	12,555.91	938.49	–	–	121,839.60
Foundation - - - - -	–	–	2,704.73	39,007.46	20,489.10	–	–	–	62,201.29
Receiving and Transporting Materials - -	–	–	–	15,651.67	19,041.16	19,519.62	3,296.27	1,407.19	58,915.91
Cutting Stone - - - -	–	–	–	15,078.61	47,622.58	115,307.69	39,017.51	28,309.53	245,335.92
Laying Masonry of Dock	51.50	838.35	1,676.73	16,812.56	28,843.47	48,787.81	12,606.43	–	109,616.85
Apron of Dock - - - -	–	–	–	–	–	–	3,483.90	–	3,483.90
Culvert and Well - - -	–	–	–	–	1,089.66	21,911.94	13,021.35	164.21	36,187.16
Gates - - - - - - - -	–	–	–	–	–	946.40	4,712.49	3,498.57	9,157.46
Permanent Drainage - -	–	–	–	–	–	647.52	1,944.94	5,963.31	8,555.77
Permanent Engine House	–	–	–	–	–	10,232.97	9,518.89	43,901.03	63,652.89
Removing Coffer-Dam -	–	–	–	–	–	1,975.25	16,926.50	898.10	19,799.85
Embankment - - - -	–	–	–	–	817.21	3,755.01	2,168.38	182.95	6,923.55
Contingent - - - - -	2,940.54	165.12	1,100.56	4,385.45	1,733.22	637.44	2,572.83	1,014.26	14,549.42
	$7,501.61	$93,119.75	$102,224.86	$186,311.22	$146,388.15	$239,077.21	$121,207.18	$90,522.51	$986,352.49

Note J.

Expenditures for Materials for the Construction of the U. S. Dry Dock, at the Navy Yard, Brooklyn, New York, from its commencement, October 22d, 1841, showing the Total Amount each fiscal year, to 31st of August, 1851.

CLASSIFICATION.	From Oct., 1841, to Aug., 1842.	From 12th Oct., 1844, to 30th Sept., 1845.	From 1st Oct., 1845, to 30th Sept., 1846.	From 1st Oct., 1846, to 30th Sept., 1847.	From 1st Oct., 1847, to 30th Sept., 1848.	From 1st Oct., 1848, to 30th Sept., 1849.	From 1st Oct., 1849, to 30th Sept., 1850.	From 1st Oct., 1850, to 31st Aug., 1851.	TOTAL.
	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.
Offices - - - - - - -	1,580.15	1,263.89	361.10	1,164.75	354.87	789.70	385.15	250.20	6,149.81
Tools and Fixtures - -	402.97	780.92	1,071.43	5,364.15	2,433.80	7,434.32	2,825.98	3,023.20	23,336.77
Temporary Drainage - -	–	6,596.87	5,423.41	12,941.85	1,511.33	–	597.00	1,444.98	28,515.44
Temporary Wharf - - -	7,661.59	282.83	–	–	–	–	–	–	7,944.42
Steam-Engines - - - -	1,400.00	3,500.00	–	4,400.00	2,567.69	1,893.76	2,231.53	409.45	16,402.43
Coffer-Dam - - - - -	13,778.34	37,886.99	33,858.68	25,890.49	198.03	–	–	–	111,612.53
Sheet Piling - - - - -	2,565.48	16,409.40	1,708.34	–	–	–	–	–	20,683.22
Excavation - - - - -	193.86	4,750.94	7,711.33	6,869.76	60.00	–	–	–	19,585.89
Foundation - - - - -	–	–	13,080.54	65,159.45	12,912.98	320.00	–	–	91,473.07
Masonry of Dock - - -	47.57	744.84	2,491.19	29,479.81	87,812.38	159,138.02	39,545.10	–	319,258.91
Culvert and Well - - -	–	–	–	–	2,163.64	4,445.90	723.19	–	7,332.73
Gates - - - - - - -	–	–	–	–	–	15,348.95	67,414.09	66,964.11	149,727.15
Permanent Drainage - -	–	–	–	–	–	2,227.08	40,555.56	33,182.43	75,965.07
Permanent Engine House	–	–	–	–	–	17,127.74	33,176.71	216,086.22	267,390.67
Removing Coffer-Dam -	–	–	–	–	–	195.68	3,106.35	3,049.50	6,350.53
Embankment - - - -	–	–	–	–	1,353.30	2,446.57	2,798.96	2,021.24	8,620.07
Contingent - - - - -	133.18	567.35	412.19	2,039.42	435.54	429.68	239.50	214.55	4,471.41
	$27,763.14	$72,784.03	$66,118.21	$153,309.68	$111,803.56	$211,797.50	$193,599.12	$327,645.88	$1,164,821.12

NOTE K.

Total Expenditures for Labor and Materials in the Construction of the United States Dry Dock, at Brooklyn, New York, from its commencement, 22d October, 1841, to 1st September, 1851.

CLASSIFICATION.	Labor.	Materials.	TOTAL.
	$ c.	$ c.	$ c.
Offices - - - - - - - -	47,981.34	6,149.81	54,131.15
Tools and Fixtures - - - - - -	17,071.12	23,336.77	40,407.89
Temporary Drainage - - - - -	39,368.76	28,515.44	67,884.20
Temporary Wharf - - - - - -	1,479.18	7,944.42	9,423.60
Steam-Engines - - - - - -	6,559.05	16,402.43	22,961.48
Coffer-Dam - - - - - - - -	98,929.74	111,612.53	210,542.27
Sheet Piling - - - - - - - -	14,743.73	20,683.22	35,426.95
Excavations - - - - - - - -	121,839.60	19,585.89	141,425.49
Foundations - - - - - - - -	62,201.29	91,473.07	153,674.36
Receiving and Transporting Materials -	58,915.91	–	58,915.91
Cutting Stone of Dock* - - - - -	245,335.92	–	245,335.92
Masonry of Dock - - - - - - -	109,616.85	319,258.91	428,875.76
Apron of Dock - - - - - - -	3,483.90	–	3,483.90
Culvert and Well - - - - - - -	36,187.16	7,332.73	43,519.89
Iron Gates† - - - - - - - -	9,157.46	149,727.15	158,884.61
Permanent Drainage† - - - - -	8,555.77	75,965.07	84,520.84
Permanent Engine House - - - -	63,652.89	267,390.67	331,043.56
Removing Coffer-Dam - - - - -	19,799.85	6,351.53	26,151.38
Embankment - - - - - - - -	6,923.55	8,620.07	15,543.62
Contingent - - - - - - - -	14,549.42	4,471.41	19,020.83
	$986,352.49	$1,164,821.12‡	$2,151,173.61

* NOTE. $98,640.14 of the above amount of cutting stone, was classified on the office accounts as materials, by being delivered by contractors as Granite, cut.

† A large portion charged Materials, for the Iron Gates, and to the Permanent Drainage (Engine and Pumps), are for Labor in their construction by the contractors, and cannot be defined by this statement.

‡ Of the Total Amount of Materials, there should be deducted $33,675 for Engines, Tools, Fixtures, &c., disposed of at the finishing of the work.

APPENDIX.

NOTE L.

DATE.	NAMES OF CONTRACTORS.	DESCRIPTION OF ARTICLES.	CONTRACT PRICE.
1845.	Nathaniel Jarvis - -	Foundation Piles - - - -	$2.12½, each to average 28 ft. long.
"	Henry Buck - - - -	Y. P. Foundation Timber -	22½c. cubic foot.
"	Henry Buck - - - -	Y. P. " Plank -	$20 per 1000 ft. board measure.
1846.	Beals & Frazer - - -	Granite Mitre Sills - - -	$38 per cubic yard.
"	William W. Wright -	Spruce Foundation Piles -	9¼c. per lineal foot.
"	Richards & Van Wart -	Rubble Stone - - - - -	$3.94 per cubic yard.
"	Frederick R. Lee - -	Hardware - - - - - -	Various kinds and prices.
"	Thornton M. Niven -	Beach Gravel - - - - -	$1.50 per cubic yard.
"	William W. Wright -	Broken Stone - - - - -	$1.90 per cubic yard.
"	M. O. Roberts - - -	Paints, Oils, &c. - - - -	Various kinds and prices.
"	J. A. Coffin - - - -	Ship Chandlery - - - -	Manilla rope, 8½c. per lb.
"	Lambert & Lane - -	Stationery - - - - - -	Various kinds and prices.
"	William N. Clem - -	Provender - - - - - -	Hay, $3 per 2,000 lbs.; oats, 45c. per bushel.
"	Corning, Horner & Co.	Iron Nails and Spikes - -	Cut nails and spikes, 4⅛c.; pressed spikes, 5½c. per lb.
"	Wetmore & Co. - -	Iron and Steel - - - - -	Various kinds and prices.
"	Badger, Peck & Co. -	Y. P. Timber - - - - -	27c. per cubic foot.
"	Frederick R. Lee - -	Hardware and S. C. Tools -	Patent hammers, 60c.
"	Tunis Craven - - - -	Cumberland Coal - - - -	$7.25 per ton of 2,240 lbs.
"	J. W. Penn Lewis - -	Driving Piles Steam Power	$9\frac{92}{100}$c. per lineal foot.
"	Campbell & Moody -	Timber and Plank - - -	W. P. timber, 19c.; W. oak timber, 27c. per foot.
"	E. W. Budington - -	Cement - - - - - - -	$1.25 per bl. of 300 lbs.
"	A. K. Messerole - - -	Building Sand - - - - -	56c. per cubic yard.
"	Gondor, Duff & Co. -	Granite Stone - - - - -	$7.56 per cubic yard.
1847.	Joseph C. Gridley - -	Provender - - - - - -	Hay, $15 per 2,000 lbs.; oats, 71c. per bushel.
"	John Meggs - - - -	Building Sand - - - - -	43½c. per cubic yard.
"	Campbell & Moody -	Timber and Plank - - -	Y. P. timber sawed square, 31½c. per cubic foot.
"	Beals & Frazer - - -	Cutting Mitre Sills - - -	40c. face, 20c. body and joints, per superficial foot.
"	Worrall & Co. - - -	Castings, &c. - - - - -	Castings, 3½c.; wrought, 10c. per lb.
"	Joseph P. Crowel - -	Stationery - - - - - -	Various kinds and prices.
"	Charles N. Decker - -	Paints and Oils - - - -	Various kinds and prices.
"	William N. Clem - -	Stone Cutters' Tools - - -	Patent hammers, 62½c.; others 25c. per lb.
"	John A. Mitchell - -	Cumberland Coal - - - -	$6.75 per 2,000 lbs.
"	Corning, Horner & Co.	Hardware - - - - - -	Various kinds and prices.
"	Tucker, Cooper & Co. -	Ship Chandlery - - - -	Various kinds and prices.
"	William W. Wright -	Broken Stone, F. Piles - -	$1.95 per cubic yd. for stone; 9¾c. per lineal ft. of piles.

Table—*Continued.*

Date.	Names of Contractors.	Description of Articles.	Contract Price.
1847.	George Smith - - - -	Rubble and Dimension Stone	Rubble $5.10; dimension, $7 per cubic yard.
"	Charles F. Codwire - -	Iron, &c. - - - - - - -	Various kinds and prices.
"	Mansfield & Downer -	Granite Stone - - - - -	$15 and $10 per cubic yard.
1848.	Campbell & Moody - -	Timber and Plank - - -	Various kinds and prices.
"	John Meggs - - - -	Building Sand - - - - -	43c. per cubic yard.
"	Thomas Nally - - - -	Castings, &c. - - - - -	Cast iron, 2½c.; wrought iron, 8c. per lb.
"	John B. Chollar - - -	Stone Cutters' Tools - - -	Patent hammers, 75c.; other tools, 26c. per lb.
"	Erastus Corning - - -	Iron and Hardware - - -	Various kinds and prices.
"	James L. Cramer - - -	Provender - - - - - -	Hay, $10.50 per 2,000 lbs; oats, 37c. per bushel.
"	Kingston Cement Co. -	Cement - - - - - - -	$1.20 per barrel of 300 lbs.
"	Lambert & Lane - - -	Stationery - - - - - -	Various kinds and prices.
"	Storer & Stephenson - -	Ship Chandlery - - - -	Manilla rope, 10c. per lb.
"	John A. Mitchell - - -	Cumberland Coal - - - -	$5.99 per ton of 2,000 lbs.
"	John A. Brown - - -	Paints, Oils, &c. - - - -	Various kinds and prices.
"	David Hamilton - - -	Rubble and Dimension Stone	Rubble $5; dimension, $7 per cubic yard.
"	Miron R. Peak - - -	Granite Stone - - - - -	See contract prices (Note D).
1849.	Pratt & Briggs - - -	Castings, &c. - - - - -	Cast iron, 2½c. per lb.
"	Bartley, Smith & Co. -	Paints, Oils, &c. - - - -	Various kinds and prices.
"	Wm. A. Wheeler & Co.	Stationery - - - - - -	Various kinds and prices.
"	John Meggs - - - -	Building Sand - - - - -	50c. per cubic yard.
"	Miron R. Peak - - -	Granite Stone - - - - -	See contract prices (Note D).
"	William N. Clem - - -	Hardware - - - - - -	Various kinds and prices.
"	D. M. Wilson & Co. - -	Iron, &c. - - - - - - -	Various kinds and prices.
"	Tucker, Cooper & Co. -	Ship Chandlery - - - -	Various kinds and prices.
"	David Hamilton - - -	Provender - - - - - -	Hay, $13 for 2,000 lbs; oats, 40c. per bushel.
"	Newark Cement Co. - -	Cement and Lime - - - -	Cement, $1.12½ for 300 lbs; lime, 75c. per barrel.
"	Henry R. Dunham - -	Iron Caisson and Gates - -	See contract prices (Note G).
"	John A. Mitchell - - -	Cumberland Coal - - - -	$5.97 per ton of 2,000 lbs.
"	Bigler & Colden - - -	Timber and Plank - - -	Various kinds and prices.
"	Gouverneur Kemble - -	Engine and Pumps - - -	See contract prices (Note H).
"	Erastus Corning - - -	Engine-House Roof, &c. -	8c. and 5c. per lb.
"	James H. Mallory - -	Brick - - - - - - - -	$6.50 per thousand.
1850.	Lock Catlin - - - - -	Provender - - - - - -	Hay, $14 per 2,000 lbs; oats, 46c. per bushel.
"	Storen & Stephenson - -	Paints, Oils, &c. - - - -	Various kinds and prices.

Note M.

CHIEF ENGINEERS.

When commenced.	Names.	When ended.
Sept., 1841.	Edward H. Courtenay - -	Aug., 1842.
Aug., 1844.	Gen. Wm. Gibbs McNeil -	Mar., 1845.
Mar., 1845.	William P. S. Sanger - -	Feb., 1846.
Feb., 1846.	William J. McAlpine - -	Oct., 1849.
Oct. 1, 1849.	Gen. Charles B. Stuart - -	Sep. 1, 1851, Completion.

CHIEF CLERKS.

When commenced.	Names.	When ended.
Oct., 1841.	James L. Watson - - -	Aug., 1842.
Nov., 1844.	F. S. Claxton - - - - -	Sept., 1845.
May, 1845.	James J. Tredwell - - -	July, 1846.
Aug., 1846.	Henry Harteau - - - -	Nov., 1848.
Feb., 1849.	Philander Shaw - - - -	Oct., 1849.
Oct., 1849.	Theophilus E. Sickels - -	Dec., 1850.

MASTERS OF MASONRY.

When commenced.	Names.	When ended.
May, 1847.	Thornton M. Niven - - -	May, 1849.
May, 1849.	Alexander Lawrance - -	Dec., 1850.

STORE-KEEPER.

When commenced.	Names.	When ended.
Nov., 1844.	William Sinclair - - - -	Sep. 1, 1851, Completion.

ASSISTANT ENGINEERS.

When commenced.	Names.	When ended.
Oct., 1841.	Henry Belin - - - - -	Aug., 1842.
Oct., 1841.	M. Warren Scott - - -	Aug., 1842.
Oct., 1844.	Julius W. Adams - - -	May, 1845.
Jan., 1845.	Allan Campbell - - - -	April, 1845.
May, 1845.	William J. McAlpine - -	Feb., 1846.
April, 1846.	Thomas S. O'Sullivan - -	Sept., 1847.
July, 1847.	John Van Nortwick - -	Feb., 1848.
Feb., 1848.	James O. Morse - - - -	Feb., 1850.
Dec., 1850.	Theophilus E. Sickels - -	Sep. 1, 1851, Completion.

MUSTER AND ROLL CLERKS.

When commenced.	Names.	When ended.
Oct., 1844.	Cornelius G. Noble - - -	Mar., 1845.
Mar., 1845.	William G. Hall - - -	Nov., 1848.
Nov., 1848.	Henry L. W. Schieffelin -	Sep. 1, 1851, Completion.

INSPECTORS OF MATERIALS.

When commenced.	Names.	When ended.
Aug., 1846.	Patrick Campbell, of Stone	Mar., 1847.
June, 1847.	William C. Smith, of Timber - - - - - - -	Nov., 1849.
July, 1847.	Thomas Ledgerwood, of Stone - - - - - -	Dec., 1849.
Jan., 1850.	Robert G. Anderson, of Stone - - - - - -	Sep. 1, 1851, Completion.
Jan., 1846.	Robert M. Whiting, of Timber - - - - - - -	April, 1847.
Aug., 1848.	Horatio Dixon, of Iron and Gates - - - - -	Sep. 1, 1851, Completion.

TABLE—*Continued.*

MASTERS OF THE DIFFERENT DEPARTMENTS.			
When commenced.	NAMES.	Department.	When ended.
Dec., 1841.	Amos Bates - - - -	Carpenters	Aug., 1842.
Mar., 1842.	William Lane - - - -	Pile-Drivers	Aug., 1842.
Oct., 1844.	Robert M. Whiting - - -	Carpenters	April, 1845.
Oct., 1844.	George Smith - - - -	Wheelwrights	Oct., 1850.
Oct., 1844.	William Lane - - - -	Pile-Drivers	Oct., 1845.
Oct., 1844.	Jerome Ryerson - - - -	Blacksmiths	Dec., 1844.
Oct., 1844.	William G. Hall - - - -	Laborers	Mar., 1845.
Dec., 1844.	John Faron - - - - -	Steam-Engines	Sep. 1, 1851.
Dec., 1844.	Alden Wild - - - - -	Blacksmiths	Aug., 1846.
Dec., 1844.	Nicholas Cornell - - - -	Stables	Mar., 1846.
June, 1845.	Andrew Thompson - - -	Laborers	Nov., 1849.
Oct., 1845.	Peter Valentine - - - -	Carp'rs and P. Driv'rs	Oct., 1847.
Mar., 1846.	Benjamin E. Lewis - - -	Stables	Mar., 1848.
Aug., 1846.	Jerome Ryerson - - - -	Blacksmiths	Dec., 1848.
Mar., 1847.	Benjamin M. Clark - - -	Masons	May, 1847.
July, 1847.	John L. Adams - - - -	Masons	Jan., 1848.
Oct., 1847.	Harman Eldridge - - -	Pile-Drivers	May, 1849.
Jan., 1849.	Edward Pell - - - -	Stables	Oct., 1849.
Jan., 1849.	David Ellis - - - - -	Blacksmiths	Jan., 1850.
Oct., 1849.	Jacob B. Striker - - - -	Stables	May, 1850.
Dec., 1849.	John H. Martin - - - -	Laborers	Sept. 1, 1851, Completion.
April, 1848.	Abia C. Entreken - - -	Masons	Dec., 1849.

QUARTERMEN OF THE DIFFERENT DEPARTMENTS.			
Oct., 1844.	Horatio S. Hamilton - - -	Carpenters	Mar., 1845.
Dec., 1844.	H. L. W. Schieffelin - - -	Pile-Drivers	Nov., 1848.
Sept., 1846.	Truman B. Brown - - -	Laborers	Aug., 1847.
Nov., 1846.	John L. Adams - - - -	Laborers	June, 1847.
May, 1846.	William C. Smith - - -	Carpenters	June, 1847.
Feb., 1847.	Robert White - - - -	Carpenters	Jan., 1850.
April, 1847.	Thomas Lidgerwood - - -	Stone Cutters	July, 1847.
July, 1849.	William Park - - - -	Masons	Oct., 1847.
Aug., 1847.	Wimund B. Sawyer - - -	Stone Cutters	Oct., 1849.
Aug., 1847.	Jacob Voorhis - - - -	Carpenters	Jan., 1848.
Oct., 1849.	Peter Valentine - - - -	Pile-Drivers	Jan., 1850.

TABLE—*Continued.*

QUARTERMEN OF THE DIFFERENT DEPARTMENTS.			
When commenced.	NAMES.	Department.	When ended.
Oct., 1847.	Leonard C. Watson - -	Masons	Jan., 1848.
Aug., 1848.	Henry H. Lugan - - - -	Masons	Dec., 1849.
Sept., 1848.	Robert G. Anderson - - -	Stone Cutters	Dec., 1849.
June, 1849.	Charles H. Wheeler - - -	Teams	Jan., 1850.
May, 1849.	Simeon Pomeroy - - - -	Masons	Dec., 1849.
Mar., 1850.	Josiah H. Crump - - - -	Carpenters	Aug., 1851.
May, 1850.	Robert Sterling - - - -	Masons	June, 1851.
June, 1850.	Jacob S. Wortman - - -	Blacksmiths	Aug., 1851.
Oct., 1850.	Peter Shand - - - -	Stone Cutters	June, 1851.
Dec., 1850.	John Stewart - - - -	Painters	July, 1851.
Dec., 1850.	Peter Smith - - - -	Coppersmiths	Sep. 1, 1851.

TABLE OF AVERAGES.

YEAR.	Average number of persons employed daily through the year.	Largest average number daily during a month.	Least average number daily during a month.	REMARKS.
1842.	29	42	12	Average of 7 months.
1844.	568	726	463	" " 2½ "
1845.	286	481	60	" " 12 "
1846.	345	549	164	" " 12 "
1847.	570	638	313	" " 12 "
1848.	307	362	223	" " 12 "
1849.	533	903	162	" " 12 "
1850.	232	533	30	" " 12 "
1851.	184	333	63	" " 8 "

NOTE.—The above is the actual number employed by the engineer for the Government, on the work, and does not include those employed by the contractors at the quarries, etc., cutting and transporting stone, which would amount during the year, to an average of four hundred, and in 1849 to about five hundred men, and during the years 1850 and 1851, by the contractors for the iron gates, and the engine and pumps, &c., to at least two hundred men daily, each of those years.

Note N.

The Rules and System adopted for conducting the Work.

A rule was established allowing each foreman to select one, and in the large gangs three, of their work men, to whom one shilling per day extra beyond the regular wages would be allowed. The selection was made semi-monthly, and the same men were not allowed to be selected twice in succession. Twice in each month the foremen and masters were required to classify their men and note their qualifications and objections. The rule has been invariably followed, that whenever a workman was reported by his foreman for any fault, he was immediately suspended, after which he was allowed to offer any explanations that he desired.

One hour in each day, viz., between 12 M. and 1 P. M., was devoted by the engineer to the hearing of complaints from the workmen and others, and applications for employment.

Mechanics were employed generally on the recommendation of the masters of the departments. The necessities and the peculiar circumstances of the work have required the employment of the workmen during the night. This labor was paid for by wages increased fifty per cent. over that done during the regular hours. The great amount of such work, and the high rate of payment, would naturally lead to abuses, which required stringent rules and close watchfulness to correct. A book was kept in which it was required to have the number of men, and the purpose entered and approved of by the engineer. Tickets signed by the engineer were then given to admit the workmen in the yard after the gates were closed. The time and the amount of labor performed was reported the succeeding day, and required the approval of the engineer before it was entered on the roll.

Order books were kept for each department, in which all work required to be done was entered and approved by the engineer, before it was allowed to be commenced.

Materials of all kinds were purchased in large quantities, and placed in charge of a store-keeper, who was not allowed to issue them except on the written order of the engineer, and then only in quantities for the day's consumption. These rules necessarily required that the engineer, or his first assistant, should be constantly on the work to prevent delays and embarrassment, in carrying on the operations, and this again brought under their constant cognizance every operation of the work, by which they were required to decide on the expediency of the expenditure of every day's labor and every item of materials used.

It is confidently believed that these rules and regulations have resulted in great economy in the construction of the work.

Note O.

Comparative Cost of the Granite Dry Docks, constructed at the Navy Yards, New York, Boston, and Norfolk.

CLASSIFICATION.	BOSTON.	NORFOLK.	NEW YORK.
	Amount.	Amount.	Amount.
Offices	50,367.45	37,365.92	54,131.15
Tools and Fixtures	43,477.04	52,575.73	63,369.37
Temporary Drainage	21,191.71	33,803.46	67,884.20
Pile Wharves	19,886.03	24,995.09	9,423.60
Coffer-Dam	18,860.61	31,606.33	245,969.22
Excavation	32,055.45	53,572.33	141,425.49
Masonry of Dock	240,456.18	455,049.06	736,611.49
Culvert and Well	24,301.22	13,762.02	43,519.89
Foundations	47,351.97	77,744.55	153,674.36
Gates	60,731.88	46,709.97	158,884.61
Permanent Drainage	14,861.88	27,945.22	84,520.84
Permanent Engine House	38,114.55	33,901.97	331,043.56
Removing Coffer-Dam	14,266.09	8,134.81	26,151.38
Embankment	20,558.08	11,468.72	15,543.62
Contingent	30,609.84	35,041.55	19,020.83
	$677,089.98	$943,676.73	$2,151,173.61

Note.—From the total cost of the New York Dry Dock, as given above, there should be deducted the sum of $33,675.00 for engines, tools, and fixtures, disposed of on the completion of the Dock, and $114,000.00 for the cost of so much of the engine house as will be devoted to machinery for the repairs of vessels, and not used for the machinery of the Dock.

NOTE P.

Extracts from the Report of Bureau of Yards and Docks, made to the Navy Department, dated October 16, 1851.

DRY DOCK AT NEW YORK.

"SINCE the last annual report, the large engine and pumps for permanent drainage have been completed and put in successful operation; the appearance, finish, and performance of the engine and pumps are highly satisfactory, and reflect great credit upon the proprietors of the West Point Foundry, where the work was executed. The great iron folding gates, built by Mr. H. R. Dunham, have been put in place and successfully tested, and they appear to answer the purpose for which they were designed, in an admirable manner. The large granite building, three hundred feet long, and sixty feet wide, part of which is occupied by the engine and pumps, has been inclosed and nearly finished. This fine building, besides accommodating the Dock pumps, affords commodious rooms for machine-shops and machinery, which when erected will supply the means for repairing steamers, and for constructing many articles required at the Navy Yard, and on board ships. The work upon the Dock was so nearly completed, as to be turned over to the commandant of the Yard on the 1st September last; a large amount of tools and other articles collected during the construction of the work, have been sold at public sale, and the Dock credited with the proceeds. The amount which has been expended upon this work, from its commencement in 1841, to the 31st August, 1851, is:

For Materials,	$1,158,543.01
For Labor,	987,712.35
	$2,146,255.36

"As this is probably the last annual report, in which it will be necessary to speak of this important improvement under a separate head, I take the occasion to state, that the manner in which the work has been conducted by the engineer, General Charles B. Stuart, and his administration of the affairs of the Dock, have been satisfactory to the Bureau; and to his energy, perseverance, and professional skill is to be attributed the successful termination of the work.

"Although the works of the Dock remained under charge of the engineer, until the 31st of August last, it was so far advanced towards completion, as to admit a vessel for repairs as early as the 8th January, 1850; since that date several vessels of large class have occupied the Dock while undergoing repairs, and great benefits have already been derived from the construction of this important work."

APPENDIX.

FLOATING DOCKS.

"The basin and railway for the Dock at Portsmouth, N. H., have been completed; the Dock is in a very advanced state, and, it is believed, that the works will be fully completed, and ready for trial, by the first of November next. The materials used, and the manner of executing the work, have been in accordance with the terms of the contract, as certified by the superintendent, and the contractors have evinced a laudable disposition to comply with their engagements in good faith.

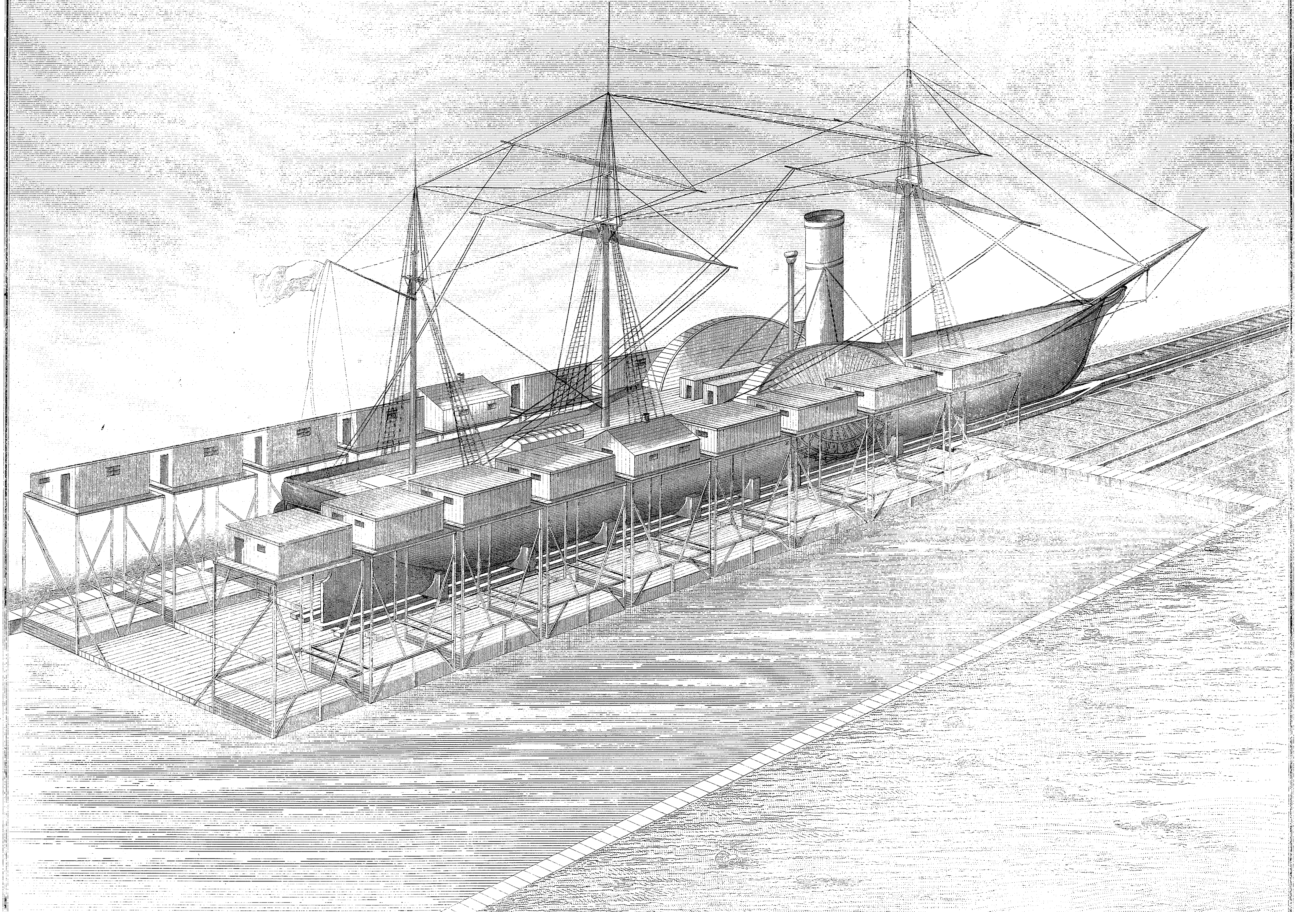
"At Philadelphia, the works have been entirely completed, and reported ready for trial, which was ordered, but owing to the want of a sufficient depth of water, the test was postponed; dredging machines are now in operation deepening the water immediately in front of the basin; as soon as this object is effected, the Dock, basin, and railways will be tested.

"At Pensacola, the works have not progressed as rapidly as at the other yards. The Dock, however, is nearly finished and ready for use; the excavation for the basin has been completed, and most of the foundation piles are driven. A large quantity of stone and other materials have been delivered, and the contractors are, under all the circumstances attending its construction, urging the work forward as rapidly as possible.

"The Department having entered into contract for the construction of a Floating Dock, for the coast of California, in accordance with the Act of Congress, dated 3d March, 1851, authorizing the same, the contractors have commenced the work with great energy, and will probably have a large portion of the Dock ready for shipment before the 1st December next."

Plate No. 7

PERSPECTIVE VIEW OF SECTION DOCK WITH STEAMER PARTLY ON THE WAYS.



PART SECOND.

FLOATING DRY DOCKS.

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CONTENTS.

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ENGRAVED BY ORMSBY.

PHILADELPHIA DRY DOCK.

HISTORY.

THE construction of this Dock was commenced in the month of December, 1849, and completed in the month of June, 1851, in compliance with the following extracts, from the Acts of Congress, relative thereto:—

Act approved March 3, 1847.—"That the Secretary of the Navy is hereby authorized to cause to be constructed, at each of the Navy Yards, at Kittery, Philadelphia, and Pensacola, a Floating Dry Dock for ships of the line, and basin and railways, at Philadelphia, on such plan as may be preferred by the Secretary of the Navy, and the sum of fifty thousand dollars is hereby appropriated towards said Dock, at Philadelphia, out of any money in the Treasury not otherwise appropriated."

Act approved August 3, 1848.—"And be it further enacted, That in execution of the Act, approved March third, eighteen hundred and forty-seven, making appropriations for the naval service, etc., directing, among other things, the construction of Floating Dry Docks, at the Navy Yards, at Philadelphia, Pensacola, and Kittery, and in pursuance of the reports in favor of the two plans, hereinafter named, as best adapted to naval purposes, made by a board of officers, appointed to examine all the plans, and by the Bureau of Yards and Docks, the Secretary of the Navy is hereby directed, forthwith, to enter into a contract with Samuel D. Dakin and Rutherford Moody, for the complete construction, within a reasonable time from the date of the contract, of a Sectional Floating Dry Dock, basin, and railways, at the Navy Yard at Philadelphia, according to the plan and specifications submitted by them to the Navy Department.

"The said works to be of the largest dimensions proposed in said plans and specifications, *Provided*, That such contract can be made at prices that shall not exceed by more than ten

per cent., the prices which have been submitted by either of the said propositions, to the Navy Department, for a Floating Dry Dock of the dimensions aforesaid. And, *Provided further*, That the Secretary of the Navy, shall also, by further contract with said parties, enlarge the dimensions of said works, at each yard, to a capacity sufficient for docking war steamers of the largest class, at least three hundred and fifty feet in length, if the dimensions above mentioned shall not be found adequate for that purpose.

"And be it further enacted, That the sum of four hundred thousand dollars, is hereby appropriated towards said works, from any money in the Treasury, not otherwise appropriated; which sum, together with the sums that remain unexpended of the appropriations made by said Act of March third, eighteen hundred and forty-seven, shall be applied towards the payments to be provided for in the said contracts."

Act approved September 28, 1850.—"For completing the Dry Dock, at Philadelphia, three hundred and seventy-one thousand, two hundred and forty dollars."

The Dock at the Philadelphia Navy Yard consists of a Sectional Floating Dry Dock, of nine sections, and a permanent stone basin, with two marine railways, extending from one of its three sides. As there are two engines on each side of the Sectional Dock, it may be used as two docks, for the purpose of lifting vessels by employing only the number of sections required for the length of the vessel to be docked. For instance, the largest ships of the line, and the largest steamers in the United States Navy, with but very few exceptions, may be docked upon six sections, while a sloop-of-war may be docked upon the remaining three; a frigate may be docked upon five sections, and smaller vessels upon the remaining four. Each of the two marine railways is so constructed, that it can receive a ship of the largest class that floats, and thus the Sectional Dock and marine railways, the construction and use of which will hereinafter be minutely described, may be said to have four capacities, or to allow four vessels to be undergoing repairs upon the Dock and ways at the same time. As several of the inventions connected with this mode of docking vessels are comparatively new, it may not be uninteresting to the reader to state some of the reasons which led to those improvements, and to give a brief history of the progress that has been made, in bringing the Sectional Dock, and its auxiliaries, to their present degree of perfection.

As long ago as the year 1802, President Jefferson, in his annual message to Congress, called attention to the necessity of building a Dry Dock, capable not only of repairing vessels one at a time, but of laying up a number at once out of the water, under cover from the weather, for preservation. In the American state papers (naval affairs) the whole subject is treated of at length. The details of the plan were presented by B. H. Latrobe, under direction of the President, and contemplated the construction of a Dry Dock in which "twelve

frigates of forty-four guns each could be laid up." Mr. Latrobe says, "it is very evident that a vessel thus secured from the weather from above, and placed with the keel one foot above high-water mark, may be perfectly drained, and rendered as safe against decay as the internal timbers of a house. In order to get rid of the foul air, which is the most rapid cause of rot, and also perfectly to drain the vessels, it may be necessary, on laying them up, to take off one streak on each side, on each floor above the gun-deck, from stem to stern. In this Dock a vessel may be built or repaired at leisure."

The plan thus proposed by Mr. Latrobe, under the direction of President Jefferson, was to use the ordinary lifting lock, supplied with a head of water from a neighboring stream, and in recommending said plan to the Congress of the United States, the President remarked, with much force and truth, "that no cares, no attentions, can preserve vessels from rapid decay which lie in the water exposed to the sun. This decay requires extensive and constant repairs, and will consume, if continued, a great portion of the money destined for naval purposes." Again, on the 9th of December, 1820, in a report made by the Navy Commissioners, on the subject of preserving timber and vessels from dry rot, after ably discussing the two plans—of immersing in water, and laying up on dry land under cover—they go on to say, "To avoid all the disadvantages of immersion, and to secure all the advantages, without any of the ills of covering timber in pieces, the Commissioners of the Navy are of opinion, that the whole frame should be put together, and planked, and bolted, and stayed so firmly, that no piece could spring out of its place or shape; and covered so effectually as to be protected against the sun, moisture, and high piercing winds, and yet to admit of free circulation of pure dry air. Ships in this state could always, when required, be finished, launched, and fitted for the service in a short time. Many instances might be adduced of the great durability of ships thus built and preserved." Escalier observes: "We perceive that wood used on dry land, kept dry and under shelter, will preserve itself for ages. A vessel afloat, in still water, and well covered, would no doubt be preserved for a great length of time; but if exposed, so as to be agitated by the waves and winds, it would be impossible to cover her as effectually as she would be on the stocks, where she would be immovable; and operated upon, as she would be in such a situation, by winds from every point of the compass, and her sides careened by such winds, would be exposed to alternate wet and dry, whence decay would ensue in the parts so exposed, and occasional repairs would become indispensable to the preservation of the ship—repairs which, obviously, would not be required on vessels kept on the stocks." The fact that vessels are preserved by placing them under cover, on dry land, is recognized by all British writers.

At the New York Navy Yard, a frigate was partly constructed in the year 1818, but not

finished for launching; she is now in nearly a sound state, in her white oak timbers and planking, as well as the live oak.

In France, as well as in England, no little anxiety is felt to this day, in consequence of the rapid decay of their vessels of war. These authorities are worthy of notice on this point, viz., Borgne's Traite Mecanique, Chap. 19, Sec. 287; also, Beledor's Arch. Hyd., Liv. 3, Chap. 12, etc.; also, Bentham's Naval Papers. Again, the Navy Commissioners, in their Report, contained in Doc. 143, XIXth Congress, allude to the danger of straining ships of large dimensions in launching them in the usual way, by a plunge into the water, and lament the want of some remedy for so great an evil; but as they knew of none, they simply state that such ships should not be coppered on their ways, because they are liable to have their copper wrinkled and injured by the process of launching. It is well known that, in Great Britain, ships of the first class are frequently constructed in Dry Docks, and afterwards floated out by opening the gates, to avoid the strain of launching. (See Encyc. Brit., Art. Dry Docks.) That this strain must be very severe in large ships, is apparent from the fact, that in the act of plunging down the inclined plane into the water, that part of the ship which enters the water is buoyed up by it, while the other part rests only upon the ways, bringing suddenly an enormous strain on her centre. This great evil, by which so many long ships have been injured or hogged, is remedied by this invention, which provides for letting them down safely into the water, constantly retaining the keel in a horizontal position.

As a further evidence of the importance which has always been attached to the subject of providing for the preservation of vessels, by means of Dry Docks, attention is called to the opinions expressed by Commodore Rogers, President of the Navy Board, in his communication, dated December 23, 1822, submitting a plan of Dry Dock by using an inclined plane to haul up ships, with a view, as he says, "to place them under cover, protected from the sun, rain, etc., without incurring the least risk; and universal experience proves that a vessel placed in such a situation, may be preserved for almost any length of time." The Hon. Smith Thompson, then Secretary of the Navy, in speaking of this method, remarks, "I have carefully examined these papers, and fully accord with the President of the Navy Board, as to the utility, and great importance of the inclined plane and dock, for the purpose mentioned in the specifications; and I recommend the same to your favorable consideration."

It will be seen from the above extracts of the proceedings of our own Government, that great anxiety was manifested through a long period of years, to adopt some plan, at a reasonable cost, for docking vessels in large numbers, for the purpose of preserving them in the most effectual manner. This anxiety, so plainly manifested at home, as well as in other countries, prompted the ingenuity of our citizens to devise the means of accomplishing that desirable end.

PHILADELPHIA NAVY YARD.

In the year 1834, Captain John Thomas obtained a patent for a Sectional Floating Dry Dock, with side chambers in the main tanks, into which water was passed or pumped out, as a balance to furnish equilibrium power to the Dock.

In 1837, Captain Thomas patented the important improvement of end floats, as a substitute for the side chambers. These end floats, in addition to the control they exert over the main tank as an equilibrium power, have since been made to serve instead of ballast, to sink it to the depth required to take on a vessel.

In the year 1841, Mr. Phineas Burgess and Daniel Dodge patented improvements in the machinery for working the pumps and end floats, which has brought this Floating Dock to its present degree of perfection.

In the year 1843, Samuel D. Dakin and Rutherford Moody obtained their patent for the permanent Platform Basin and Marine Railways, as auxiliaries to Floating Docks; by which means as many vessels may be placed on shore under shelter, in a short time, by one Floating Dock, as there are marine railways and ship houses, or sheds, constructed for their reception. At Philadelphia, three more marine railways may be constructed on the north side of the Basin, while only two could be built on the south side, in consequence of the direction of the Port Warden's line. These railways may be built at small expense, and when completed, the same Floating Dock and Hydraulic-Cylinder now used, could be used in connection with them. Thus, at but little cost, the four capacities of the Philadelphia Dock would be increased to nine, and the object so long desired, by the authorities above quoted, be fully attained.

DESCRIPTION.

LOCATION.

The Basin and Ways are located in the south-east corner of the Philadelphia Navy Yard, upon the Delaware river, in Southwark. A large part of the yard in the vicinity of that river has been formed, from time to time, by extension of the piers. The Basin is located between the south pier of the Navy Yard, and the south pier of the frigate-house, extending into the river as far as the Port Warden's line, regulating the extension of the wharves of Southwark, will permit. Two sets of marine railways are located at the head of the Basin, at equal distances from its sides, with a turn-table at the head of each set of Ways.

CHARACTER OF SOIL.

The first strata of soil is a mud of rich loam, and extends from a little above low water mark, declining toward the bottom of the river, which is of a clean gravel, to the depth of about twenty-four feet below ordinary low tide. It is evidently the deposit, through a long period of years, of the earthy matter held in suspension by the waters of the river, upon a stratum of sand and gravel, forming the bed of the river. The strata of sand and gravel are not more than from four to seven feet in thickness, before those substances become mingled with paving stones, large boulders, and, to some extent, with clay, forming a species of hard pan, to which all the piles used in the construction of the foundations of the work were driven.

COFFER-DAM.

In consequence of the character of the soil, and the open crib-work of some of the old piers underlaying a portion of the surface of the Navy Yard, at the head of the basin, through which the water from the river flowed freely, it was found necessary to inclose the space required for the construction of the basin, by a Coffer-Dam on every side. This important piece of work was commenced in January, 1849, and prosecuted with vigor until the month of May, 1850, when it was completed.

On the river side two rows of large ribbon piles, of oak, were driven twenty feet apart, and cut off three feet above high tide. They were then halved out, both at the top and at low water mark, to receive large oaken ribbons, inside of which two rows of yellow-pine piles, sixteen feet apart, were driven closely, so as to form the two sides of the Coffer-Dam. Those piles were all from thirty-eight to forty-three feet long.

The two sides were connected, as the work progressed, by iron bolts of two inches in diameter, through the lower tier of ribbons, and tied by oak beams locked on to the top ribbons, three feet apart. The Dam was then filled with earth. On the land side the construction was precisely the same. On the south side the arrangement was similar, only the south pier was used instead of one row of sheet piling. It was impossible to drive a line of piles on the north side of the pier of the frigate-house, in consequence of the foundations already prepared for that structure. The single line of piles was therefore driven on the south side of that pier, and connected with it by two-inch iron bolts and oak ties; and bracing was then placed against the floor timbers and piles, in a part of the foundation of the work, before the earth, directly against the inside of this line of piles, was removed. The whole Coffer-Dam being thus far completed and filled, the cross beams or ties were covered with four-inch plank, to form a roadway with the south pier, around the basin, to enable the contractors to deposit the material necessary for the construction of the work.

DRAINAGE OF COFFER-DAM AND EARTH WORK.

An appropriation having been made for the extension of the south pier, to the extreme end of the basin, one of the cribs was so constructed before sinking it, as to leave a large well connected with the space where the basin was to be built. Three plain lifting-pumps

were placed in this well, to the depth of about thirteen feet below ordinary high-water mark, which were worked by an engine of twenty-horse power. A temporary house was built over the engine and pumps. The pumps were each twenty-four inches in diameter, four feet stroke, and could discharge ninety-two gallons to the stroke, working at sixteen strokes per minute. After the earth became well settled in the Coffer-Dam, the pumps were only required to be in motion about one third of the time, and the extra power of the machine was used for a planing machine, to prepare the timber for the construction of the sections and the ways. The extent of excavation required was an average of two hundred and seventy feet long, and about two hundred and forty feet wide.

A portion of the space in the vicinity of the channel had to be filled up.

The earth excavated was all a rich loam. An addition had been made to the south pier on the north side, in the way of the south wall of the basin, consisting of strong crib-work, filled with earth and stone, which had to be removed at great labor and expense. The total amount of earth excavated was about fourteen thousand cubic yards; four thousand cubic yards of which were removed with carts and barrows, and the remainder by the dredging machine below low tide.

FOUNDATION OF BASIN AND CONCRETE WALL.

The object of this foundation was to give support to the bottom of the basin, and to secure the outer edge of it from the action of the current of the river. As the excavation was completed, hemlock and yellow-pine piles were driven, four feet apart from centre to centre, in rows, from one end of the space to the other.

An extra row of piles was driven under the line of the walls, for the three sides of the basin. A separate space was then formed, by driving a line of sheet piling, eight feet from the inner line of piles of the Coffer-Dam.

Two extra rows of piles were driven within this space, which was then filled with concrete to within two feet of the surface of the floor of the basin. The piles thus driven were all cut off to the same level, capped with timbers one foot thick, and at least one foot wide, extending to the inner line of the Coffer-Dam, and the interstices between these capping timbers filled up with earth and concrete.

Pieces of timber, sixteen by eighteen inches, were placed across the width of the basin, resting on the capping timbers, and treenailed to them where they crossed; to which each pile of the inner line of piles of the Coffer-Dam, was fastened with an iron bolt. When the Coffer-

Dam was removed, this inner line of piles was cut off to the level of the floor of the basin, and now forms the outside of the concrete wall. The dimensions of the foundations of the basin, are two hundred and thirty-six feet wide, and three hundred and fifty-five feet long.

MASONRY OF FLOOR AND WALLS.

A level floor of granite, ten inches in thickness, covering the whole of the area, properly dressed, and in pieces averaging two feet by five, was laid to complete the level platform required to receive and sustain the Floating Dock with the vessel upon it, before sliding it upon the marine railways on the shore. On three sides of this space, walls of granite were built corresponding to the specification (see Appendix, Note A, and Plate Three), except that it was found desirable to raise them eighteen inches higher, to place them above the general level of the wharves of the Navy Yard. All this masonry was of granite, laid in hydraulic cement. The face stone and coping of the walls are of cut stone, and the entire surface of the stone floor was dressed, as nearly as possible, to an exact level.

MARINE RAILWAYS AND CRADLE.

The foundations of the marine railways were constructed with much care, and in conformity with the specification in the Appendix (see Note B). Piles were driven capped with timber, which was covered with heavy masses of granite, cut upon the upper surface to a perfect level, to receive the bedways of white oak. Each marine railway consists of three parallel ways, the top surface of which nearly corresponds with the surface of the Navy Yard. The centre way is intended to sustain the weight of the vessel upon her keel, and the other two ways at equal distances from the centre way, to keep the vessel steadily upon her keel, during the operation of sliding her on shore. The temporary bedways are intended to be placed upon the deck of the dock, accurately alligned with the bedways on shore.

The cradle is constructed to be placed under the keel and bilges of the vessel, to sustain her with her keel upon the centre bedway, and her bilges upon the bilge-ways. For this latter purpose each side of the vessel is blocked up with square blocks of timber, from the bilge-way of the cradle.

The bedways upon the railways on shore, and those used on the deck of the dock together with the cradle, are all made of the best white oak.

HYDRAULIC CYLINDER, ENGINE HOUSE, AND TURN-TABLES.

The hydraulic cylinder, exhibited in Plate Five, was built at the "Novelty Works," New York city, for a detailed description of which, see Appendix, Note C. The bore of the cylinder is fifteen inches diameter, and its ram is nine and a half feet in length. Two engines of twenty-horse power each, with locomotive boilers, drive the four pumps that force the water into the cylinder, producing a power estimated to be equal to eight hundred tons lift.

The engine house covers the hydraulic cylinder. It has substantial stone foundations, and brick superstructure, with large double doors in the direction of the principal ways and cross-ways, to allow the cylinder and engines to be moved from the turn-tables, upon either of the ways.

The turn-tables are constructed in the floor of the engine-house, as represented in Plate Two, Figure Three, and described in Note C, of Appendix. They are used to turn the cylinder and engines, after a vessel has been hauled on the ways, previous to pushing her off again, or to turn them in the direction of the temporary crossways, which are used to transfer them from one set of marine railways to another.

DESCRIPTION OF FLOATING SECTIONAL DOCK.

This Dock consists of nine sections, differing from each other only in their width, three of them being thirty feet, and six, thirty-two feet wide.

They are constructed as represented in Plates One and Two; and fully described in Appendix, Notes D, E, and F.

Each section consists essentially of a main tank, two end frames, and two end floats.

The main tank is one hundred and five feet in length, thirty-two or thirty feet in width, eleven feet high at the ends, and eleven feet six inches at the centre. The longitudinal and transverse truss-frames, which are placed within the tank, and the large iron bands by which the timbers of each truss are bound together, give all the strength required for the raising of the heaviest vessels; and it will be seen by referring to the plans and details of the construction, that the object has been to give great strength to the transverse centre of the tank, under the line where the keel of the vessel is to rest. Two timbers are placed under this line,

and upon the deck of the main tank, six inches thick, and making together a width of three feet, upon which the keel-blocks are placed. Perpendicularly to the line of keel-blocks, bilge-block ways are fastened to the deck, over the centre longitudinal trusses, upon which bilge-blocks, suited to the various forms of vessels, are slid (by means of ropes extending to the platform), for the purpose of sustaining or shoring the vessel.

The air-box in each end frame, is graduated to feet and inches, for the purpose of indicating the depth of the keel-blocks below the surface of the water. Gauge-rods properly graduated, show the quantity of water pumped, consequently the lifting power exerted by each section, with great accuracy, and thus the weight of a vessel upon the Dock may be ascertained. The lifting power of this Dock, and its weight, are given in Appendix, Note G.

Horizontal shores, graduated to feet and inches, extend from each end frame, and are made to slide out or in, to reach the side of the vessel, to keep her in the centre of the Dock, until the keel-blocks are brought against her keel. Hinge-shores are also provided, to be used when required, from the ends of each section, to aid in shoring the sides of the vessel.

There is placed in each end frame, a float connected with four posts of the framework, by two shafts, with small cog-wheels on each end, which work into pinions, properly fastened upon one side of each of these posts, by which the machinery raises the end floats, so as to throw their weight upon the end frame, to sink the main tank to the depth required, or to depress the end floats so as to give additional buoyancy to the section, and thus to serve as an equilibrium power, to keep the ends of the main tank on a level.

When the Dock is to be used, the number of sections necessary to make up, by their breadth, the length required for the keel of the vessel to be docked, are joined together by connecting beams so arranged, as, that after the vessel is lifted, and the beams keyed up, the several sections become as one structure. These beams are so arranged for sliding out and in, as to allow of their being placed at any distance apart, from six inches to six feet, if required by the length of the vessel, although it is not deemed advisable, with heavy vessels, to separate them farther than three feet, the usual distance at which keel-blocks are placed from each other.

There are two beam-engines of twenty-horse power, and two of twelve-horse power, each with locomotive boilers, which move the machinery for working the three pumps, at each end of each section, and the end floats. When the nine sections are arranged into two Floating Docks, two of the engines are used in common with each Dock. The shafting, which conveys the power of the engines from one section to another, runs into a hollow sliding-shaft, and may be slid in or out, as may be required by the proximity of the sections, as fixed by the connecting rods of timber. Between the sections there is an universal-joint in the shaft, to provide

for any deflection there may be in the line of shafting extending along and over the platforms.

The nine sections, above described, united to form a Dock, and placed only three feet apart, possesses great advantages for coppering and repairing vessels.

It has a floor or deck, more than three hundred feet long, by one hundred and five feet wide. This floor, made up of sections, yields and conforms itself to the shape of the keel of the vessel. It brings the keel above the surface of the water of the river, into light and dry air. It is capable of extension, contraction, or division, in adapting itself to the length of the vessel, and in forming two separate Docks, each independent and perfect in itself. It is capable of raising the heaviest ships in two hours. It is easily repaired, as one section may be raised by two others for that purpose.

MODE OF DOCKING A SHIP.

After the Dock is properly moored, from the south pier northward, the end frames on the west side, ranging in a line near the gates, the main tanks are filled with water, and the Dock still floats. The end floats are then elevated by the machinery upon the end frames, until the keel-blocks are sunk by the weight of the end floats, one or two feet more—below the surface of the water—than the draft of the ship to be docked. The ship is then hauled over the dock, and placed by the graduated wail-shores in the centre of the dock. The end floats are pressed into the water, until the keel of the ship has a bearing on the keel-blocks. The workmen pass rapidly from one end frame to another, and by the ropes reaching to each platform, haul the bilge-blocks, now under water, with great facility against the bilge of the ship. The pumps are now started, and every ton of water taken from the tanks, raises one ton of the weight of the vessel, until her keel is above the surface of the water. As there are three pumps at each end of each section, all of equal capacity, it is very easy to regulate the quantity of water to be taken from each section, with reference to the difference of weight of the stern, waist, and bow of the vessel; and it may be done with great accuracy, by referring to the guage-rods, extending to the platforms of the end frames of each section.

MODE OF TAKING A VESSEL ON AND OFF THE BEDWAYS.

If the keel of the vessel upon the Floating Dock is not in a perfect line, the bottom of the sections will not form a plane surface. It is necessary that this point should be attended to before landing the Dock upon the level floor of the basin. This is done by depressing those sections which float the highest, and by adding to the blocking under the keel, to the extent of the depression. It is also desirable to place keel-blocks eighteen inches higher than those used for ordinary purposes, in order to allow room for the bedways upon the deck of the Dock, and the cradle upon which the vessel is to slide.

The Dock, drawing from eight to ten feet water with the vessel upon it, raised entirely above the surface of the water, is then hauled into the large basin constructed for the purpose, by means of the capstans, placed at intervals on each side. The line of the keel of the vessel is then placed in a line with the centre bedway; the tanks are then filled with water, to settle the Floating Dock firmly upon the level stone platform of the basin. The bedways placed on the deck of the Dock, and connecting with those on shore with the cradle, both properly slushed, are now introduced, and blocks are put in between each bilge and the bilge-ways. The regular bilge-blocks are now withdrawn. The hydraulic cylinder is attached to the head of the sliding-frame by large wrought-iron hauling beams, and the movement commenced, which is carried on eight feet at each movement, until the vessel is slid upon the bedways in the Navy Yard. If the cradle should be required for another vessel before the first is repaired, it may be taken readily apart, and used to place another vessel upon the other bedways. It the vessel requires essential repairs, there are shoring-ways arranged on each side of the bed-ways, similar to those used in the ship-houses of Navy Yards, upon which the vessel may be properly shored. To return the ship to the Dock, the hydraulic cylinder is reversed upon the turn-tables, and instead of pulling, it pushes against the head of the sliding-frame, until it has delivered the vessel again upon the deck of the Dock.

FLOATING GATES.

The floating gates are two rectangular boxes, made with white-oak frames, inclosed with yellow-pine plank, well caulked and pitched, and covered with a sheathing of oak boards, on the top and bottom, and of white-pine boards on the sides. They are sufficiently long to reach

across the basin, on the river side, and are useful as an addition to the line of wharves of the Navy Yard; also, in preventing any thing from floating into and sinking upon the floor of the basin; also, as a roadway, from one pier to the other, and as a convenient place of deposit alongside of the Floating Dock, when in its position for docking vessels, for the receipt of the materials necessary for their repairs.

NAMES OF ENGINEERS, CONTRACTORS, AND AGENTS.

William P. S. Sanger, ... Engineer of the Bureau of Yards and Docks, located the Basin and Ways at the Philadelphia Navy Yard.

Col. Ward B. Burnett, ... U. S. civil engineer, superintended its construction, from its com mencement to completion.

Phineas Burgess, ... Engineer for the contractors.

Dakin & Moody, ... Contractors.

J. T. Dean, ... Agent for the contractors.

Larned & Legerwood, D. Kennedy, ... Sub-contractors of masonry.

COMPLETION AND COST OF WORK.

The Sectional Floating Dock, Basin, and Marine Railways, with all their appurtenances, as described in the contract and its accompanying specifications, was completed on the 5th day of June, 1851, and its total cost, under the contract, was as follows:—

For the wood-work and machinery of six sections, thirty-two feet wide, at $41,206.96 each,	$247,241.76
For the wood-work and machinery of three sections, thirty feet wide, at $38,860.31 each,	116,580.93
For the floating gates and extension of pier, constructed by order of the Secretary of the Navy, in lieu of one section thirty feet wide,	38,860.31
For Coffer-Dam complete,	80,000.00
For concrete wall,	20,000.00
For excavation and levelling for foundation of basin,	20,000.00
For driving piles for foundation of basin,	50,000.00

For capping the piles, and planking over them for floor of basin, . .	25,000.00
For laying the stone floor of basin, ...	60,000.00
For building side walls of basin, ...	60,000.00
For driving foundation piles of ways, and capping them, ...	15,000.00
For stone-work on the ways, ...	35,000.00
For bedways and cradle, ...	20,000.00
For hydraulic cylinder, engine, and engine house, ...	26,059.00
Total cost, . . .	$813,742.00

THE TEST OF THE DOCK, BASIN, AND RAILWAYS.

SINCE the first edition of this work was issued, the Dock, Basin, and Railways, described in the foregoing pages, have been fully and satisfactorily tested, by taking out of the Delaware river and placing upon the railways the "CITY OF PITTSBURGH," an ocean steamship two hundred and forty-seven feet in length, (about fifty feet longer than a ship-of-the-line,) and weighing twenty-seven hundred and eighty tons, including the machinery, and two hundred and forty tons of coal.

Six of the nine sections of the Floating Dock were sunk in thirty-six feet water, in front of the basin; the vessel floated over them, and secured in the centre of the Dock by the shoring-ways and bilge-blocks.

The pumps were then put in operation, and, in little over one hour, the ship was buoyed out of her element without the least difficulty; a jolly-boat could not, to appearance, have been disposed of more easily. The Dock was then hauled into the basin, and rested on the stone floor, so as to bring the bedway or cradle on which the ship was placed, on a level with the railways in the Navy Yard, to permit the hauling of the vessel from the Dock. The hydraulic locomotive accomplished this in the most successful manner in about *seven* hours, placing her, a grand spectacle, upon *terra firma*, at a distance of nearly three hundred feet from the Dock. The ship was moved in her cradle, the whole distance, gently, smoothly, noiselessly, without the least strain, breakage, or delay from any cause, and the power required to draw her was ascertained to be less than *one-fourth* of the whole power which the hydraulic apparatus is capable of exerting.

In addition to the description already given of the hydraulic cylinder, it may be well to

mention, that the power is obtained by forcing water into a hollow cylinder, which forces the piston out, and the frame-work supporting the vessel being attached to the cross-head of the piston, the whole vast bulk is moved together. The apparatus remains immovable, being securely keyed to the railway; but as soon as the piston is forced out to the full extent, the keys are removed, and the engines surmounting the cylinder, which previously worked the pumps that forced the water into the cylinder, now form the motive power of the apparatus, which is driven along upon the railway, until the piston again occupies its original position in the cylinder, when the same *modus operandi* is again gone over.

The movement of the piston averaged one foot per minute while hauling the vessel, and, including the fleeting and keying, the time occupied for each *eight* feet of movement was about *twelve* minutes.

When pushing the vessel back on the railways, after it had been stationary for three days, the time required was sixteen minutes, and the power about one-fourth more than when hauling ashore.

The inventors of this new method, who were also the contractors, (as before noted,) are Messrs. Dakin & Moody, of New York, who have evinced a high degree of mechanical ingenuity and skill, and are worthy of great commendation for the successful manner in which they have thus brought their valuable improvement into practical use, and put this, their *first* work built on their new plan, in successful operation, without the slightest defect, or a moment's delay throughout the whole process. Much of this triumphant success is due to the admirable working of the hydraulic apparatus, invented by Horatio Allen, Esq., an eminent civil engineer of the city of New York, who also guaranteed to the contractors the perfect working of the "*hydraulic locomotive*," the success of which novel invention reflects great credit upon his professional skill and acquirements.

The important results attained in multiplying the capacity for docking vessels, by the basin and railways, which is the novel feature of this new system, stamps it as one of the most important inventions of the day, and, like the telegraph and other kindred inventions, is purely American. No other known plan of Dry Docks is capable of taking more than one line-of-battle ship out at once, but by this new method any number of any known size can be taken out of the water and placed ashore, being limited only by the size of the basin and the number of the railways.

CALIFORNIA DRY DOCK.

HISTORY.

By an act of Congress of the United States, approved on the 28th of September, 1850, entitled, "An Act, making appropriations for the Naval Service, for the year ending 30th June, 1851," the Secretary of the Navy was authorized to enter into a contract, for the construction of a Sectional, or Balance, Floating Dry Dock, with basin and railways on the coast of California.

By a subsequent act, approved March 3d, 1851, entitled, "An Act, making appropriations for the Naval Service, for the year ending 30th June, 1852," the first act was so far modified and repealed, as to authorize the Secretary of the Navy to confine the sums appropriated (two hundred and fifty thousand dollars) to the construction of a Floating Dock alone, without the basin and railways, provided the Secretary of the Navy considers the estimates made by the department for the construction of said work, to be "fair and reasonable."

Previous to the passage of the last act referred to, the Bureau of Yards and Docks had furnished estimates for the construction of a Floating Sectional Dock, with basin and railways, for California, based upon the cost of materials and labor at the Pensacola Navy Yard, as required by the first act. After the passage of the Act of March, 1851, the Secretary of the Navy referred the estimates submitted to the department, to the Engineer-in-chief of the Navy, with instructions to examine the same, and to estimate the probable cost of a Floating Dock, of ten sections, of a capacity to raise and sustain for repairs, a ship of the line, of five thousand three hundred tons displacement, or a war steamer of the largest class, of not less than three hundred and fifty feet in length.

The Engineer-in-chief (C. B. Stuart) submitted to the Secretary of the Navy, in April,

1851, the plans, specifications, and estimates of cost, for the proposed Dock, delivered ready for use, in the Bay of San Francisco.

Hon. Wm. A. Graham, Secretary of the Navy, in the month of May following, selected from the two Docks included in the first-named law, the "Sectional Floating Dock," as preferable for the coast of California, to the "Balance Floating Dock;" also some suitable place within the waters of the Bay of San Francisco, as the location for the Dock; approved of the plans and specifications, and entered into a contract on the 19th May, 1851, in behalf of the Government, upon terms he considered fair and reasonable, for the construction of the Sectional Floating Dock, with Samuel D. Dakin, Rutherford Moody, John S. Gilbert, and Zeno Secor, all of the City and State of New York, to be constructed in accordance with the plans and specifications submitted by the Engineer-in-chief, at such places or points on the coast of the Atlantic or Pacific Oceans, as they might prefer; but all the parts of the Dock are to be delivered to the United States, put together complete and in every respect ready for use, in raising vessels of the capacity and dimensions named in the specifications, and sustain them for repairs, at such point in the Bay of San Francisco, as the Secretary of the Navy shall hereafter, and before the Dock shall be ready to set up, designate.

The work to be commenced forthwith, and completed in all respects, within two years from the date of contract, and to progress in its several stages and periods of construction, in proportion to the time stipulated for its entire completion.

The contract price was six hundred and ten thousand dollars, payable in the following manner, to wit:—

When bills certified by the Superintendent Engineer on the part of Government, and approved by the Commandant of the station where the work or any portion of it shall be prepared on the Atlantic, or by the Superintendent of the work in California, and approved by the Commander of the Pacific Squadron, or such other person as the Secretary of the Navy shall from time to time appoint, shall be presented, showing that each or any section is framed, and the whole of the materials of every description for such section, except the machinery are prepared or ready for shipment, there shall be paid the sum of fourteen thousand dollars —that the whole of the machinery to make each, or any section complete, has been prepared, or is ready for shipment, there shall be paid the further sum of thirteen thousand four hundred and fifty dollars:—that the whole of the materials, including machinery, iron, copper, etc., for each or any section, shall be received at the point designated in California by the Government, and the truss-frames ready to be set up; there shall be paid the further sum of eighteen thousand, three hundred dollars:—that each or any section shall have been launched and fully completed in every respect, machinery set up, and all ready

for immediate use, there shall be paid the further sum of fifteen thousand, two hundred and fifty dollars.

Each of the payments to be made by the Navy Agent at New York or San Francisco, within thirty days from and after the presentation of bills duly certified and approved, excepting and reserving from each of the payments, ten per centum, as security for the faithful performance of the work (in addition to two hundred thousand dollars bond), and after the completion and satisfactory trial of the Dock, as provided in the contract, the ten per centum reserved and retained, to be paid to the contractors. The Government to provide a ship of the line, or steamer of the largest class, to test the Dock, within three months after notice of its completion.

The contract also provides that all the materials and work, which may be shipped on the Atlantic coast, for California, shall be fully insured, and the policies of insurance made payable, in case of loss, to the United States.

In conformity to the contract, the construction of the Dock was commenced in the city of New York, foot of Fifteenth street, North river, in June, 1851, under the immediate superintendence of the engineer-in-chief of the Navy, assisted, in the inspection of materials and machinery, by Samuel McElroy, assistant engineer of the United States Navy, from August to January, 1852, and by Colonel Ward B. Burnett, superintending engineer of the Philadelphia Sectional Dock, from February to April, 1852.

On the 1st of January, 1852, the contractors had delivered nearly all the timber for the ten sections of the Dock, had framed, put together, and marked ready for shipment, four sections, and completed the machinery for eight sections.

On the 1st of February, they had completed the machinery for the whole Dock, including the four engines and boilers, framed six sections, and delivered all the materials for them ready for shipment; and on the 1st of March, they had two additional sections framed and ready to ship, with all the materials belonging to them; and the timber for the remaining two sections delivered and partly framed. The Dock is to be shipped to California early in the spring of 1852, around Cape Horn, in vessels of from one to two thousand tons burden, previous to which, all the machinery will be carefully covered with two coats of zinc paint, and packed in boxes, to protect it; and the frame-work of the sections, after being put together complete, will be marked and numbered in such a manner as to readily put them together again, after the timbers (many of them very large) are taken from the vessel. All the woodwork that is planed will also be covered with zinc paint, before shipping, and again painted after it is put together in California.

DESCRIPTION.

THE California Floating Sectional Dry Dock, is constructed in nearly the same manner as the Sectional Dock, at the Philadelphia Navy Yard, with the following important exceptions, viz:—

There are *ten* sections, each one hundred feet in length, thirty-two feet in breadth, and eleven feet nine inches in height, with two end floats to every section, each twenty-six feet eight inches long, fifteen feet wide, and eight feet high.

There is also used, in the construction of the California Dock, in *addition* to the material in the Philadelphia Dock, one hundred and seventy-four thousand pounds of sheathing copper, thirty-five thousand pounds of copper spikes and nails, and two hundred bales of Russia felt, required to protect the Dock in the waters of the Bay of San Francisco.

It being deemed advisable to reduce the width of the end floats, from those of the Philadelphia Dock, portions of the shafting and gearing of the pumps were necessarily slightly altered in their arrangements, to conform to the floats built for this Dock.

The engines, boilers, and machinery for this Dock, were constructed at the "Novelty Works," and the "Archimedes Works," in New York, and at "Burden's Works," in the city of Brooklyn. The pumps were made at "Brown's Foundry," in Water street, New York. The mechanical execution of the various parts of the machinery, reflect much credit upon the respective establishments where they were made.

The wood-work of the Dock is composed of the best quality of northern white oak and white pine, and of southern yellow pine. The two first named qualities being mostly from Canada West and western New York, and the last from the states of Georgia and Florida. No timber was allowed to be put into the work, that had not been cut over one year previous

to being used, and the plank two years. All the timber, before being framed or used, was examined by the inspector, (Darius Peckham,) and afterwards inspected by the Government engineers, before it was marked and shipped. The working plans for the framing and putting together the sections, were furnished by Phineas Burgess, engineer, and the supervision of the framing by Nathaniel S. Wing, and Melville De Pue, master carpenters.

The displacement and lifting power of the California Dock, *exceed* that at Philadelphia, about ten per cent.

For the details of the materials and workmanship of the California Sectional Dock, reference is made to the Appendix, and Plates, accompanying the Philadelphia Dry Dock.

PORTSMOUTH DRY DOCK.

HISTORY.

THE Balance Floating Dry Dock is the invention of John S. Gilbert, Esq., of the city of New York.

This Dock, with basin and railways, was contracted for by the Secretary of the Navy, on the part of the Government, with John S. Gilbert and Zeno Secor, on the 11th of November, 1848, under an Act of Congress, approved August 3d, 1848, to be completed within three years.

Previous to the adoption of this plan of Dock by the Government of the United States, it had been extensively used for the commercial marine of the largest class, both in this country and in Europe, patents having been purchased of the inventor.

There are two Dry Docks on this plan now in use in the city of New York (one of them for twelve years), and another, of very great capacity, will soon be completed in that city. At the cities of Charleston, Savannah, Mobile, and New Orleans, they are also in successful operation.

DESCRIPTION.

LOCATION.

THE Portsmouth Navy Yard is situated in the state of Maine, on an island in the Piscataqua river, about three miles from its mouth, and directly opposite the city of Portsmouth, N. H. In this yard, originally named the "Kittery" Navy Yard, is this Dock located, immediately on the bank of the river.

BASIN AND RAILWAYS.

A Coffer-Dam having been constructed in the usual manner, of adequate dimensions and strength to exclude the water from the pit excavated for the foundations of the basin, the bearing piles were then driven, in rows four feet apart, through the earth, to the solid rock which forms the substratum of the island. They were then cut off on a level, twelve feet below ordinary high-water mark, and capped with timber, levelled off with earth to the top of the timbers, and the whole surface of the bottom of the basin covered with five-inch plank, and the joints or seams caulked with wedges of soft wood well driven in.

The basin and railways are exhibited in Plate Eight. The interior dimensions of the basin are three hundred and sixty feet long, and one hundred and twenty feet wide on the bottom, the walls, fourteen feet in height, battering back three feet on all sides, from the bottom to the top of the basin.

Suitable courses of cut stone are laid upon the bottom timbers of the basin, in the direction of its length, forming *five* level walls, projecting one foot above the timbers, to form a

bed on which to rest the Dock, while the vessel is being drawn off on the cradle to the shore. The spaces between the walls, or courses of stone, is filled with a layer of concrete, six inches thick, entirely covering the plank flooring. The walls of the basin are made of cut granite of large dimensions, laid in hydraulic cement; near the outer ends of the side walls, and across the bottom of the basin there is a groove, six inches deep, and two feet wide, to receive the keel and stems of the floating gate used to inclose the Dock within the basin.

The floating gate is constructed similar to those in the ordinary stone docks (see Plate Eight, Figures Three and Four), and is used to keep out the floating ice and other bodies that might injure the Dock, and to shut out the tide, when it may be necessary to examine or repair the copper on the bottom of the Balance Dock.

The depth of water in the basin, at ordinary high tide, is ten feet above the projecting courses or walls of stone. The railways connected with the basin, are constructed in the same manner as those at the Philadelphia Navy Yard, with engines, hydraulic cylinder, and cradle of like character and dimensions, for the purpose of hauling vessels from the Dock to the shore.

The cost of the basin and railways was two hundred and eighty-two thousand, five hundred and eighty dollars; and the floating gate, thirteen thousand dollars.

THE BALANCE FLOATING DRY DOCK.

The dimensions of the Balance Dock are, length, three hundred and fifty feet; breadth, one hundred and five feet four inches; depth, thirty-eight feet. The chambers on each side are seven feet eight inches wide, reducing the interior width to ninety feet. The inclosing gates at each end, shut against the outside of the Dock, and, therefore, do not reduce its internal length.

The Balance Dock, though founded on the Caisson principle, is not merely a Caisson Dock, but may be described in general terms as a combination of the Caisson and Camel, united in the form of a walled Dock, having a middle compartment in which the vessel rests, after the water is pumped out, as exhibited in Plate Eleven.

This combination is made by butting the side compartments, or balancing chambers, with sloping inner walls, into a Caisson, and giving to the structure great strength and massiveness by interwoven bracing and trussing, both transverse and longitudinal, as seen in Plates Nine and Ten, and described in Appendix, Note H.

Such, in general terms, is the Balance Dock, so designated from the facility of preserving an exact equilibrium and level by means of water let into, or pumped out, the separate com partments of either of the side chambers, there being eight of these compartments in each of

the side chambers, all communicating with the pump-well in the centre of the chamber (as seen in Plate Eleven), by means of valves. The power, therefore, of preserving the level of the Dock, both transversely and longitudinally, as it rises with its load, is ample.

That portion of the sides which extend above the windows or ports, is termed the upper or ballast chamber. As the Dock is almost entirely constructed of yellow-pine timber, it will readily be seen that it will not sink, by its own specific gravity, low enough to admit vessels of great draft, and therefore, to sink the Dock to receive vessels of the largest class, these upper chambers are filled with water ballast, by means of the engines and pumps, by which the water is also pumped out of the Dock.

This Dock has inclosing gates at its ends, extending up as high as the bottom of the windows, but, by reference to Plate Nine, it will be seen that these gates are only necessary when vessels of great weight are to be lifted. The inclosing gates are composed of yellow-pine timber and plank, strongly trussed and secured by suitable iron fastenings.

There has been used in the construction of this Dock two hundred and fifty-four thousand cubic feet of yellow-pine timber and plank; one hundred and fifty-two tons of iron, and sixty-three tons of copper fastenings; ninety-one tons of locust treenails; sixty-six tons of thirty-two ounce copper sheathing; seventeen tons of copper nails; and one hundred bales of Russia felt.

THE ENGINES AND PUMPS.

Engines of adequate power, placed on the top of the side chambers, drive the pumps, which stand upon the bottom of the Dock chamber, as shown in Plate Ten, Figures Two and Three.

The pumps are made of white-pine plank, five inches thick, fastened with screw-bolts. They are each two feet square, and ten feet long, with three feet stroke. The pump boxes are of composition, surrounded with leather to prevent the chamber of the pump chafing. The valves are of gutta-percha, and of the kind denominated "butterfly." They have a tight deck around them at their tops, so arranged that all the water which they lift from any part of the Dock, passes out through openings provided in the side of the Dock chamber, on a level with the heads of the pumps. Pumps of similar construction, made of white pine, have been used in a Balance Dock, in New York city, for eleven years, and are still in good working order. For details of pumps, see Appendix, Note G.

MODE OF DOCKING A VESSEL.

Preparatory to docking a vessel on the Balance Dry Dock, the pumps are set in motion by the steam-engines on the deck above, and the discharge opening being closed by a gate for that purpose, the water rises in the chamber above the pumps, until it is full to the deck of the Dock. It is then allowed to flow into the upper chamber of the Dock, until its weight operates as ballast to sink the Dock to any required depth, as all the water which is raised above the general level is ballast, the bottom of the upper chambers being four feet above tide, when the Dock is sunk its greatest depth. To sink it deep enough to receive a ship drawing twenty-five feet water, it is necessary to pump two hundred and forty tons of water ballast into each side chamber. When the ship is in the Dock and in position to be raised, this ballast is drawn off by opening valves in the lower side-chambers, thereby causing the Dock to rise by its own specific gravity, until it touches the bottom of the ship.

The operation of lifting the vessel is then performed by first pumping the water out of the side chambers and the bottom tank, and as the Dock rises with its load, the water around the ship in the middle chamber ebbs out, so that the quantity of water to be exhausted in raising a vessel, is in proportion to her weight, and does not depend upon her bulk. The time ordinarily required to dock a vessel of two thousand tons displacement is two hours.

ENGINEERS AND SUPERINTENDENTS.

The engineer of the Bureau of Yards and Docks (Mr. Sanger) located the basin and railways of this Dock, and the Government engineer in charge of their construction was Alexander Parris, C. E. The Floating Dock was superintended the first two years of its building by B. F. Delano, U. S. naval constructor, and thereafter, until its completion, by naval constructor Samuel Hart. The engineer of the basin and railways, on the part of the contractors, was Warren Q. Dow, and the superintendent of the Dock was, for the first two years, James McCay, and after that period, John M. Weeks, both assisted by Isaiah Hanscorn, as master carpenter.

The Portsmouth Dock and its appendages were completed in the month of November, 1851, at a cost to the Government of seven hundred and thirty-two thousand, nine hundred and five dollars.

TEST OF THE PORTSMOUTH DOCK, BASIN, AND RAILWAYS.

Since the first edition of this work was issued from the press, the Balance Floating Dock, Basin, and Railways, at the Portsmouth Navy Yard, have been thoroughly tested by the raising and hauling off and on the railways, the United States (seventy-four gun) ship-of-the-line "Franklin," being one hundred and eighty feet long on the load line, and weighing, when docked, (free of spars and armament,) about twenty-three hundred tons.

This Dock, like the one at the Philadelphia Navy Yard, has, it will be remembered, the extraordinary capacity for laying up vessels in ordinary, under cover, in housed slips on the land, in which ships may be constructed and thence moved on the railways to the Floating Dock, from which they may be launched gently and quietly, preserving a horizontal position during the whole process, instead of making a rapid plunge down an inclined plane, which always strains long vessels more or less seriously.

The "*hydraulic locomotive*," used to draw the vessel on and off the railways of this Dock, is precisely similar to the one already fully described as attached to the Philadelphia Dry Dock, it having been constructed at the "Novelty Works," under the immediate supervision and in accordance with the patent of Horatio Allen, Esq., of the firm of Stillman, Allen & Co., of New York city.

The power exerted by the "*hydraulic locomotive*," in hauling the ship ashore, upon an *inclined* railway of one foot in one hundred, or nearly *fifty-three feet to a mile*, *was less than one-third its power*, and in pushing it back, *not one-tenth* of its vast force was used. The whole test was made successfully, without the least accident or failure, and occupying less than a day to haul the vessel entirely ashore; thus proving the Floating Dock, Basin, and Railways, a monument of American ingenuity, energy, skill, and mechanical science.

PENSACOLA DRY DOCK.

HISTORY.

The Dry Dock now constructing at the Pensacola Navy Yard, was contracted for by the Secretary of the Navy with John S. Gilbert and Zeno Secor, the 25th October, 1848, under an Act of Congress approved August 3d of that year, to be completed by the 1st of May, 1851, for the sum of nine hundred and twenty-one thousand, nine hundred and thirty-seven dollars, including the basin and railways.

Owing, however, to the site selected for the basin being obstructed by buildings and materials of various kinds, the ground was not cleared, so as to allow of the commencement of the basin, until one year after the contract was entered into. This delay, together with the adverse circumstances under which the foundations of the basin were constructed (a full description of which is given under the head of Basin and Railways), has prevented the completion of the work within the time limited in the contract. The Balance Dock is now completed, and the basin will probably be finished by the first of June next.

DESCRIPTION.

LOCATION OF THE BASIN.

The basin for the Balance Dock is located on Tartar Point, in the Bay of Pensacola, at the south-east corner of the Navy Yard. The entrance to the basin fronts the south, and is approached from the Bay, through a canal or channel one hundred and twenty feet wide, and three hundred feet in length.

CHARACTER OF THE SOIL.

The soil is a clean white sand, extending to a depth of about forty feet, and resting upon a deep bed of soft clay. The sand is so clean that water filtered through it is perfectly clear, and so open that a cubic foot of it, when saturated, contains six quarts of water. It extends back from the shore of the Bay, from a fourth to half a mile. By excavating at the shore, or any point back, within the distance named, *fresh* water is found at the level of the Bay, with the remarkable feature of *rising* and *falling*, in perfect regularity with the *tides* of the Bay.

CONSTRUCTION OF THE COFFER-DAM.

Considering the extreme hardness of the sand, and its being so porous, it was deemed almost, if not altogether, impracticable to construct a Coffer-Dam which would be tight enough

to admit of the basin-pit being pumped out, to allow the foundations and the walls to be laid. It was found impossible to drive piles to a greater depth than about twenty feet, and to accomplish that, hammers of two tons weight had to be used.

The difficulties were, however, finally overcome by the contractors in the following manner. To form a basis for calculating the amount of leakage in a given space, and the power necessary for the practical operation of the pumps, required to drain the pit to be excavated for the basin, a space of fifteen feet square was excavated within a curb of wood, to the depth of the proposed foundations of the masonry. A wooden pump was worked by a small engine, at a fixed number of revolutions. The crank of this pump was so arranged that the stroke could be lengthened or shortened, until the leakage and the discharge of the pump were equalized. Having in this manner ascertained the amount of the leakage in a given space, the requisite pumps, and power to drive them, was determined, and the Coffer-Dam commenced in the following manner.

A space of one hundred and forty feet wide, and three hundred and eighty feet long, was inclosed by driving yellow-pine piles, twelve inches square, to the depth of about twenty feet into the sand, placed in contact with each other; and a row of anchor piles was also driven twelve feet apart, and at a distance of twenty feet in rear of the sheet piles, entirely around the Coffer-Dam. A ribbon, twelve inches square, was then bolted upon the inside of the sheet piling, and ties of the same dimensions were then halved on to the anchor piles, and lapped on to the ribbons, to prevent the sand from pressing in the rows of sheet piling when the earth was removed from the inside of the dam.

This having been done, the space inclosed within the dam was excavated to a depth of fourteen feet below tide, by one of Osgood & Carmichael's steam dredging machines, worked on a float, as the nature of the soil was such that the machine could dig itself afloat by excavating sand to a little below the level of the Bay.

The basin-pit having thus been excavated, a second row of sheet piles, like the first, was driven inside, at a distance of three feet from them, and the space between the two rows, was filled with clay well mixed and puddled.

BASIN AND RAILWAYS.

Having completed the Coffer-Dam, a steam-engine of twenty-horse power, with pumps sufficient to employ it in lifting the water over the top of the dam, was erected. Taking the experiment with the curb fifteen feet square, to determine how large a section of the pit,

the pumps and engine would exhaust, a cross dam of two rows of sheet piling was made at a distance of thirty-five feet from the head of the basin. The pumps were then put in operation, and in three hours this section was pumped dry, and the leakage hourly decreased, much to the surprise of the contractors and others.

Upon examining the clay filling between the rows of sheet piling, it was found that it had settled considerably, and upon looking for the cause, it was discovered that the hydrostatic pressure of the water on the outside of the Coffer-Dam, was forcing the fine particles of clay through the sand into the pit, and giving to the water a milky color. This continued but a short time, when the interstices of the sand being entirely filled, the sand and clay formed a cement entirely impervious to the water. The cross sections afterwards made in the pit were double the length of the first. After the section of the pit had been excavated to the level of the foundations, the bearing piles were driven, in rows four feet apart, and four feet from centres, in each row, until a ram of twenty-two hundred pounds, falling thirty feet, could not move them more than half an inch.

Upon the transverse rows of piles, cap timbers, twelve inches square, were placed, and the spaces between the timbers filled with sand. The timbers were then covered with five-inch yellow-pine plank, firmly spiked to the caps, and the whole floor caulked with wedges. On this flooring the masonry of the basin was commenced, and in addition to the end and side walls, there are laid in the middle portion of the basin three parallel ranges of granite stone, to serve as the immediate support of the Dock, whenever it may be grounded in the basin. During the time the masonry was being built in the first section of the pit, the second one had been finished, ready for the removal of the first cross dam, and the commencement of the stone-work.

This economical plan of constructing the basin was proposed by J. S. Gilbert, Esq., one of the contractors, who also personally made the various experiments already noted. The difficult task of constructing the work has been in charge of Warren Q. Dow, Esq., the engineer of the contractors, who has performed a work pronounced by experienced engineers as impossible of successful accomplishment.

After the death of Mr. Hale, of Boston, the superintending engineer of the Government (who was drowned last year in endeavoring to save the lives of the crew of a vessel shipwrecked in the Bay, near the Navy Yard), James Herron, Esq., has been the superintending engineer of the basin on the part of Government.

The novel character of the sand upon which the basin was based, caused the Government engineer (Mr. Herron) to apprehend great danger from the hydrostatic pressure against the floor, when the Dock was empty, the weight of the Balance Dock being five thousand tons; or

that the pressure upon the bearing piles, when to the weight of the Dock should be added that of a ship of the line placed thereon, of five thousand, three hundred tons. The contractors and their engineer were confident that the plan of foundations specified in their proposal and contract, was free from the apprehended danger. In this opinion the chief engineer of the army, (General Totten), and the engineer-in-chief of the navy, fully coincided, upon the question being referred to them by the Secretary of the Navy.

To *test* the point at issue, however, between the Government engineer and the contractors, the chief of the Bureau of Yards and Docks (Commodore Smith) directed the commandant of the Pensacola Navy Yard (Captain Newton) to have six of the piles first driven for the foundations drawn up, carefully noting the power required to draw them, and to furnish the length, diameter at the top and bottom, and their weight, also the average dimensions of all the piles used, when prepared ready for driving. The results of these interesting experiments are given in Appendix, Note J, and fully establish the safety and stability of the contract plan for the foundations of the basin.

The bearing piles in the foundations, twelve inches in diameter, will each have to sustain (when the Dock and line-of-battle ship is in the basin) about *seventeen* tons; and when the Dock only is in the basin, and the water pumped out, will have to resist an upward action of about *five* tons each. The experiment showed that a single foundation pile used as a fulcrum for the lever, sustained nearly *thirty-nine* tons without settlement, and would undoubtedly sustain much more; and that it required forty-one tons strain to draw a pile that had been driven sixteen feet into the sand. The detailed description of the basin and boat gate are given in Appendix, Note K. The railways and hydraulic cylinder are the same as those constructed for the Philadelphia Dock.

THE BALANCE DOCK.

The Floating Balance Dock at the Pensacola Navy Yard, being precisely like the one at the Portsmouth Yard, except that it will be provided with extra fixtures to steady vessels, when it is used as a camel for carrying them over the bar in the Bay, the description of the one, already given, will apply equally to the other.

The Pensacola Dock was superintended by E. H. Delano, U. S. naval constructor, until near its completion. Samuel Hart, Jr., is now the superintendent on the part of the Government.

COST OF THE WORK.

The contract price for the work at the Pensacola Navy Yard, including camel properties, is, for the Floating Dock, five hundred and fifty-five thousand, seven hundred and twelve dollars; for the basin and railways, three hundred and fifty-three thousand, two hundred and twenty-five dollars; and for the floating gate, thirteen thousand dollars.

DESCRIPTION OF PLATES.

SECTIONAL FLOATING DRY DOCK.

Description of Plate One.

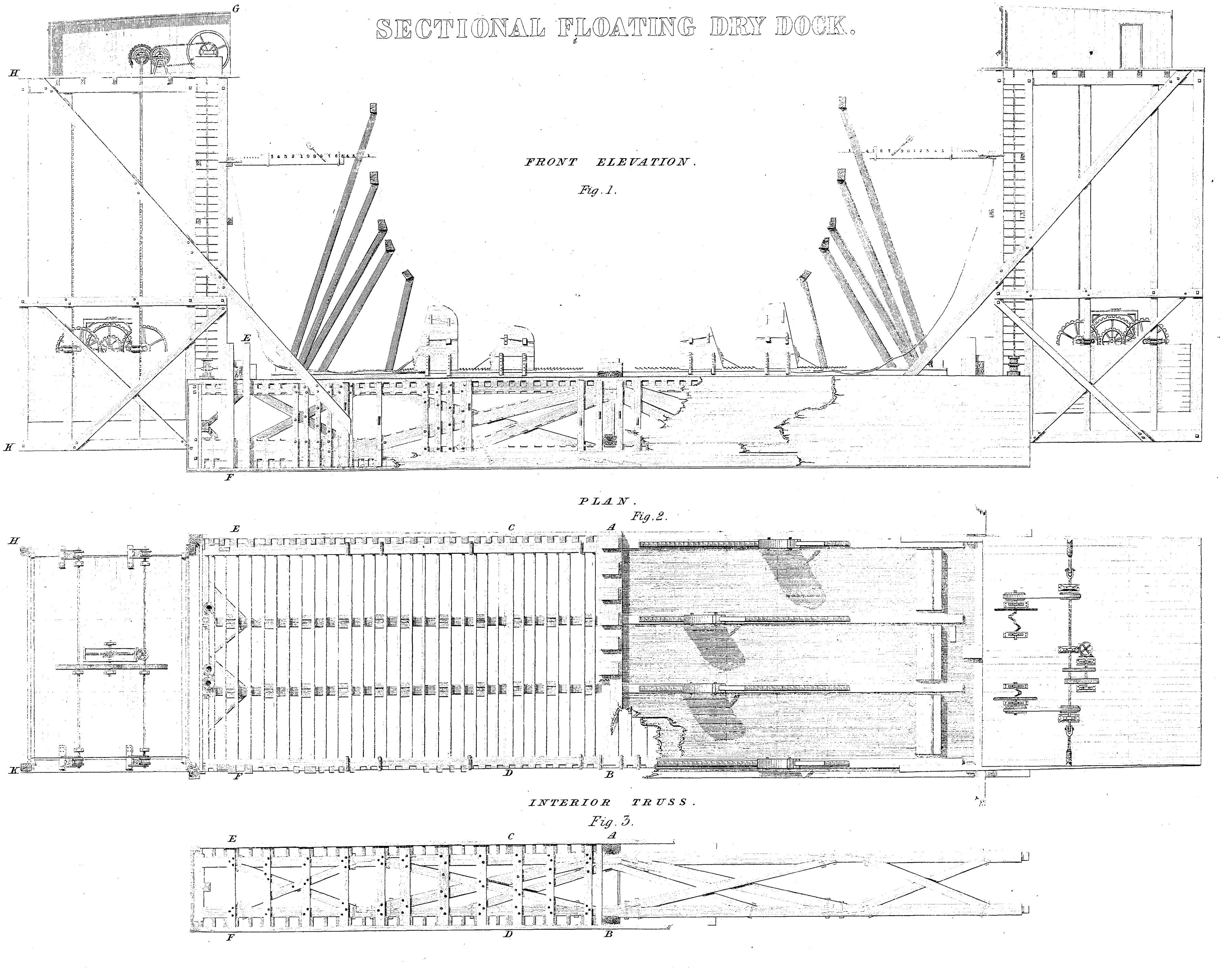
Figure One, shows a front elevation of a section and end floats, with the bilge-blocks and hinge-shores, in place, to support a vessel on the Dock. The left of the engraving shows the framing of the section, and the right, the planking on the outside of the same.

Figure Two, is a plan of a section. The left of the plan shows the framework, and the right, the deck, with the bilge-ways and bilge-blocks.

Figure Three, is an elevation of the interior truss of a section. The right shows the framing of the truss, and the left, the corner pieces, studding, and ends of the floor timbers.

The letters on this Plate correspond to those in the specifications for the purpose of reference.

SECTIONAL FLOATING DRY DOCK.



A. Plinta. C.E.

"Stuarts" Naval Dry Docks of the United States.

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DETAILS OF SECTION, AND PLAN OF TURN-TABLE, AND CROSSWAYS.

Description of PLATE TWO.

FIGURE ONE, exhibits a section of end float, elevation of end frame and engine house, with the pumps and their connections.

FIGURE TWO, shows the elevation of end float, and exterior elevation of end frame.

FIGURE THREE, is a plan of turn-table and crossways, for moving engine and hydraulic cylinder from one railway to another.

FIGURE FOUR, shows an elevation of the end of a main tank, partly planked, with the valve gate to admit the water, to sink the Dock preparatory to receiving the vessel.

FIGURE FIVE, shows a plan of an end float, with the deck partly laid.

FIGURE SIX, is a section of the main tank, through A B.

FIGURE SEVEN, is a section of A B, through D B.

FIGURE EIGHT, is a section of main tank, through C D.

FIGURE NINE, is a section of C D, through B B.

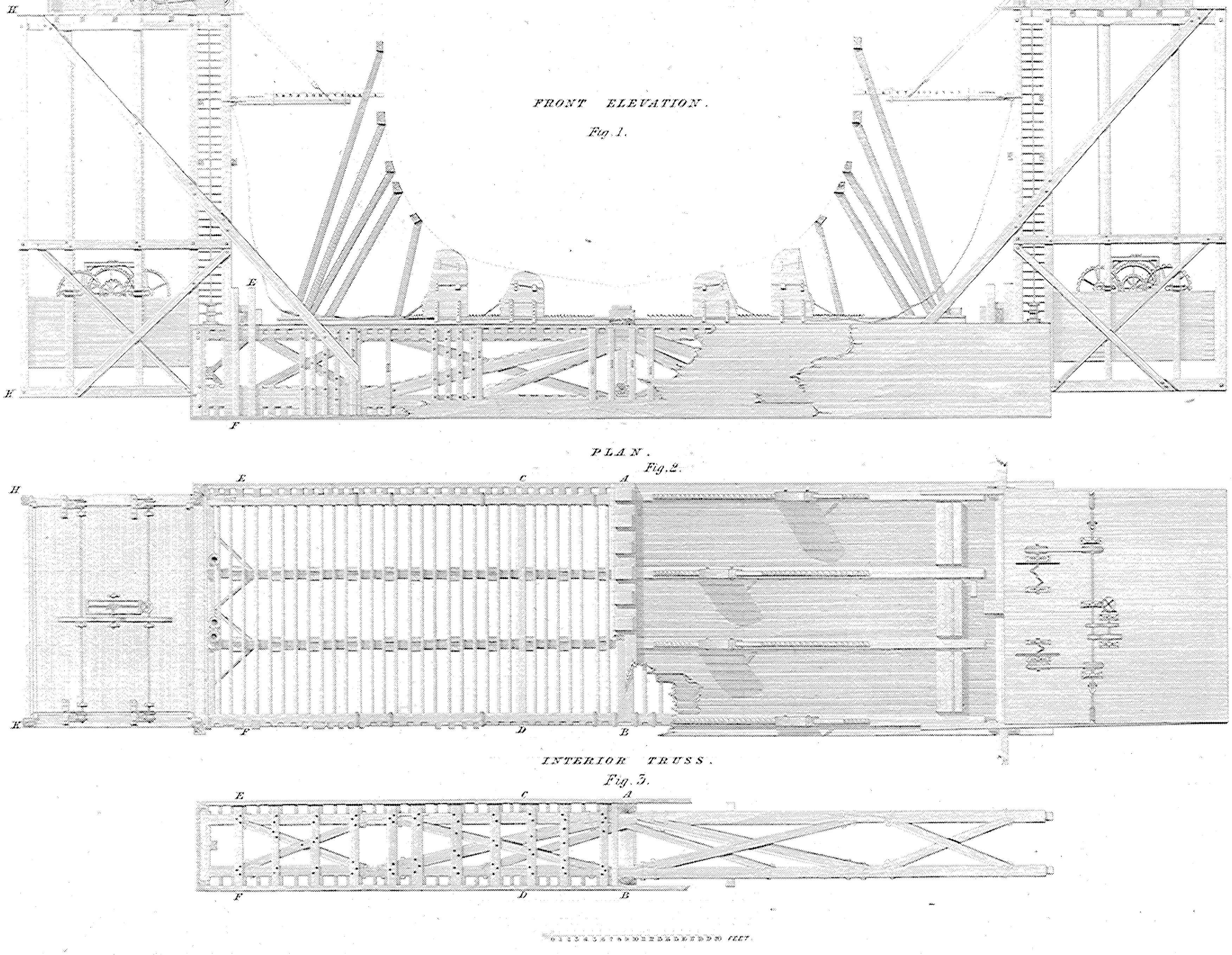
FIGURE TEN, is a side of float, partly planked.

FIGURE ELEVEN, is a section through the centre of float.

FIGURE TWELVE, is an end of top, and bottom of a main tank.

FIGURE THIRTEEN, is the plan of strap used to secure the framing.

SECTIONAL FLOATING DRY DOCK.



A. Pinto, C.E. "Stuart's Naval Dry Docks of the United States." Engd. by W. L. Ormsby.

PLAN OF BASIN AND MARINE RAILWAYS.

Description of PLATE THREE.

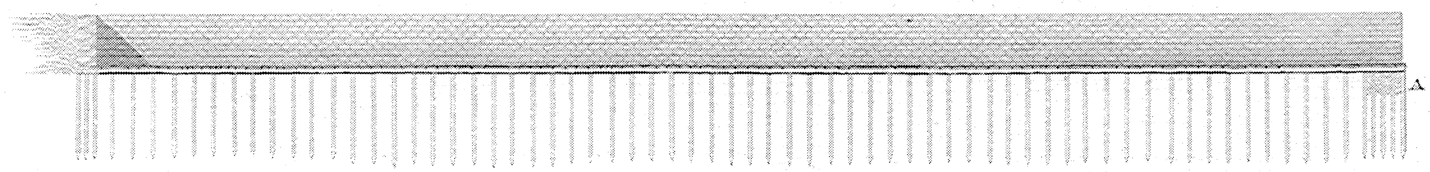
FIGURE ONE, shows the plan of basin and ways, with shoring-ways.

FIGURE TWO, is a longitudinal section of the basin, showing the bearing piles and foundation timbers.

FIGURE THREE, is a transverse section of the basin, showing also the concrete wall.

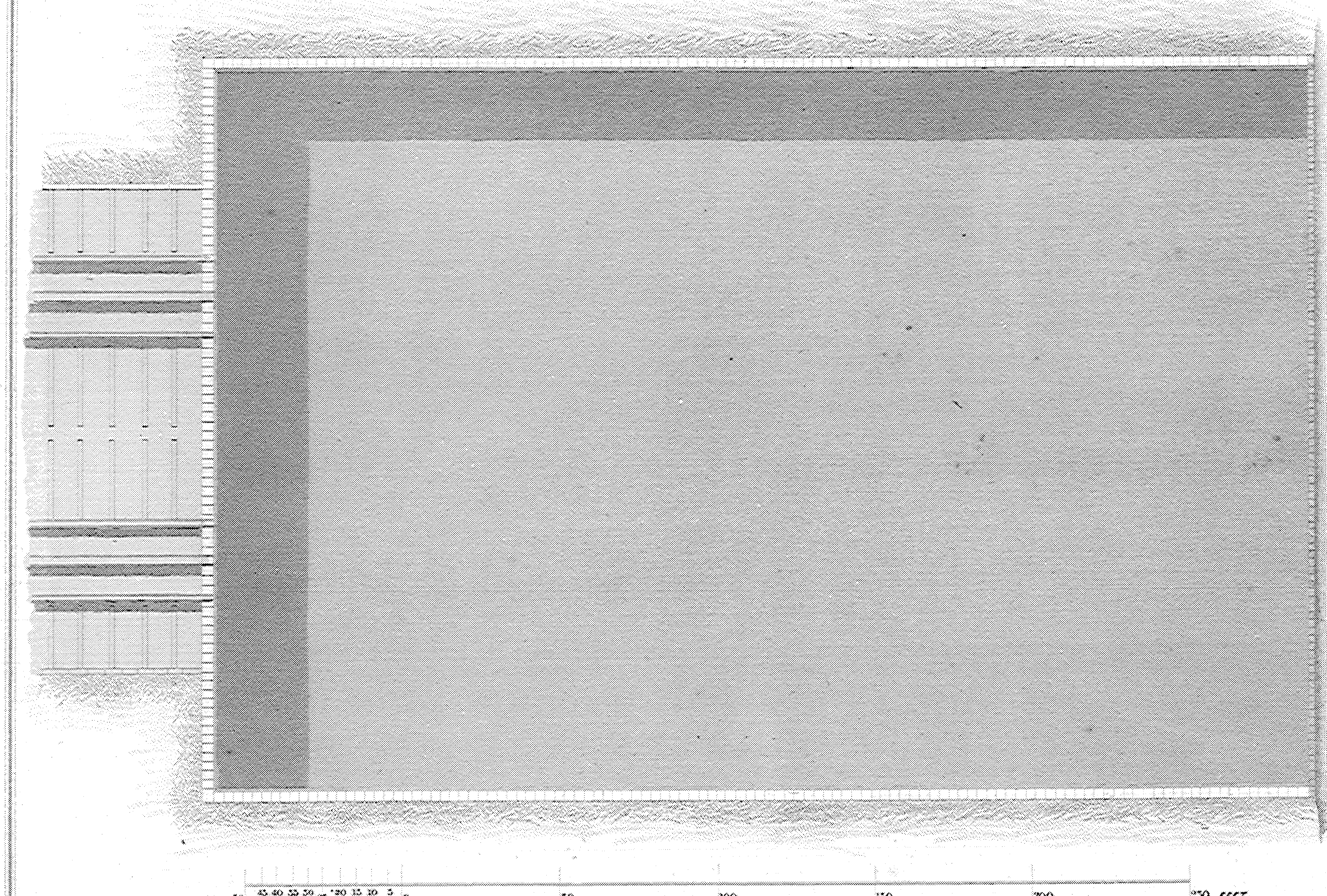
LONGITUDINAL SECTION.

Fig. 2.



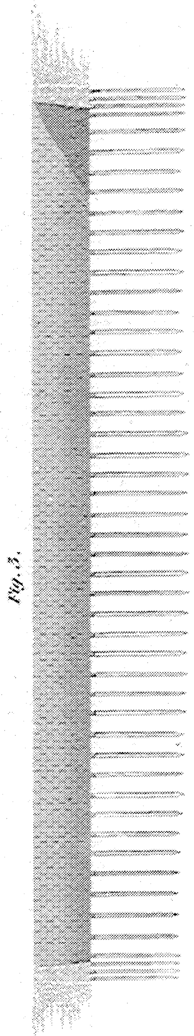
PLAN OF BASIN AND WAYS.

Fig. 1.



CROSS SECTION.

Fig. 3.



A. Fintz, C.E.

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PLAN OF SLIDING-FRAME AND ELEVATION OF PUMPS.

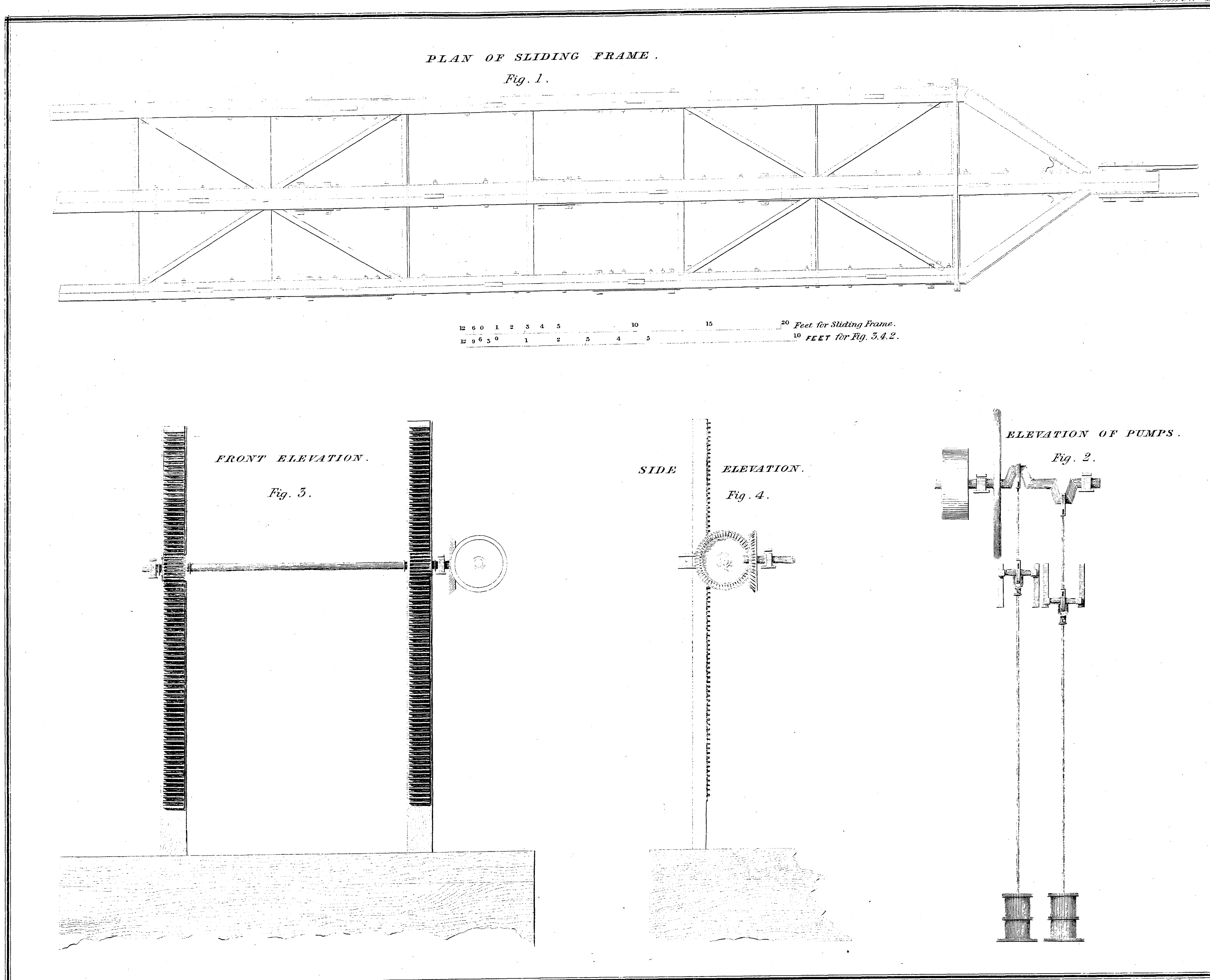
Description of PLATE FOUR.

FIGURE ONE, is a plan of the sliding-frame and cradle, used when drawing vessels from the Dock to the shore.

FIGURE TWO, shows an elevation of the pumps and band-wheels, for each of the nine sections of the Dock.

FIGURE THREE, is a front elevation of the pinion-wheels, rack, and gearing connections.

FIGURE FOUR, is the side elevation of the same.



"Stuarts" Naval Dry Docks of the United States.

HYDRAULIC CYLINDER AND ENGINE.

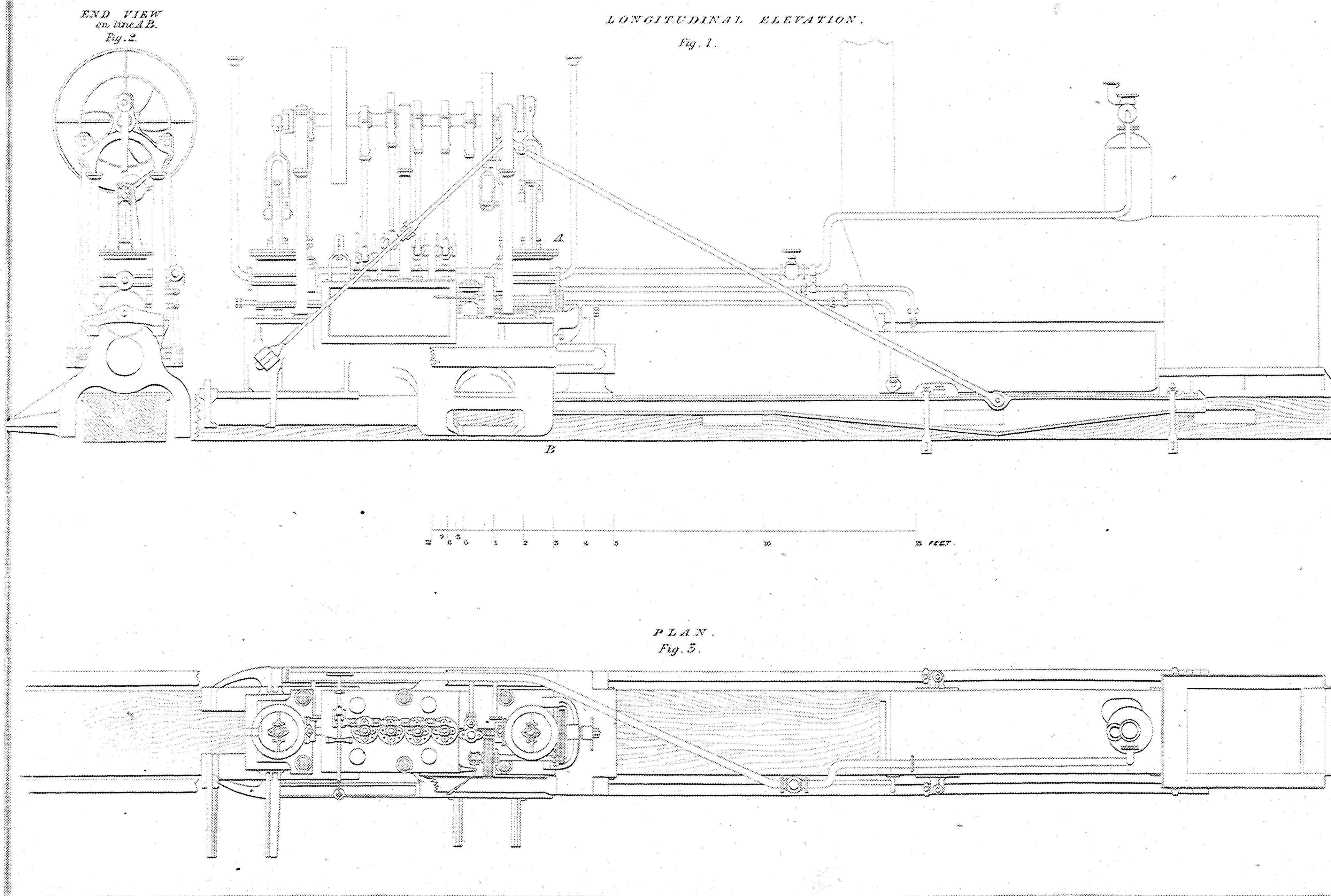
Description of Plate Five.

Figure One, is a longitudinal elevation of the hydraulic cylinder, engines, boiler, and water tank, resting upon the centre bedway.

Figure Two, is an end view of the hydraulic cylinder and engines, on the plane A B.

Figure Three, is a plan of the cylinder, engine, and boiler.

HYDRAULIC CYLINDER FOR THE U.S. DRY DOCK PHILADELPHIA.



A. Pinta, C.E. "Stuarts" Naval Dry Docks of the United States. Engd by W.L. Ormsby.

GENERAL PLAN OF GEARING FOR PUMPS AND END FLOATS.

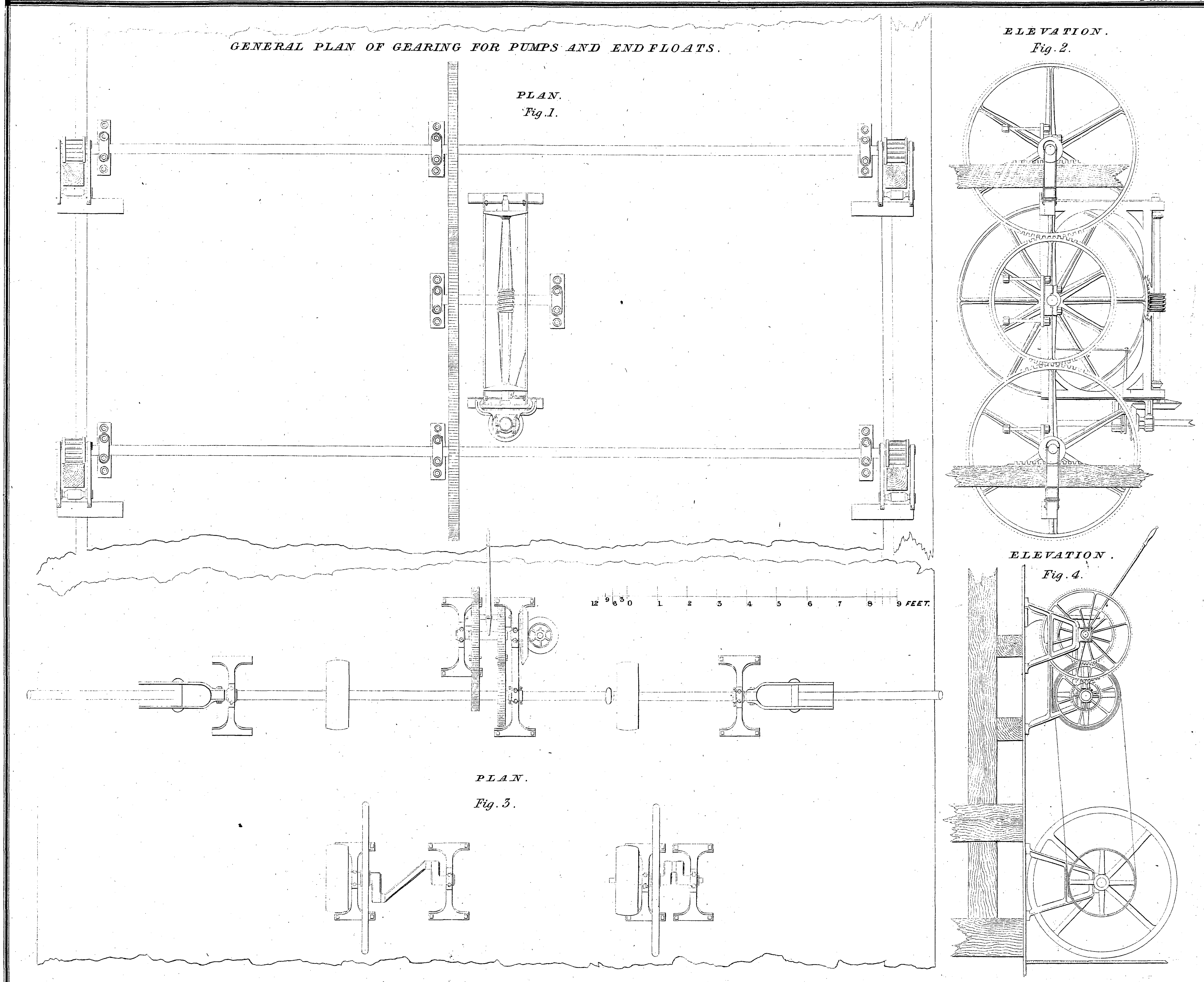
Description of PLATE SIX.

FIGURE ONE, shows a general plan of the gearing of pumps and end floats, for one section of the Dock, the residue being the same.

FIGURES Two and FOUR, are an elevation of the same.

FIGURE THREE, is a plan of the same.

GENERAL PLAN OF GEARING FOR PUMPS AND END FLOATS.



A. Pinta. C.E.

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PERSPECTIVE VIEW OF SECTIONAL DRY DOCK, BASIN, AND RAILWAYS

Description of PLATE SEVEN.

[*See Frontispiece of* PART TWO.]

PLATE SEVEN, shows a perspective view of the nine sections of the Floating Dock, resting upon the floor of the basin, with a war steamer of the largest class being hauled on to the bedways, ashore, from the Dock, by the power of the hydraulic cylinder and engine.

PLAN OF BASIN FOR THE BALANCE FLOATING DRY DOCK.

Description of PLATE EIGHT.

FIGURE ONE, shows the plan of the basin, with the stone walls or ways, on its bottom, to rest the balance dock upon.

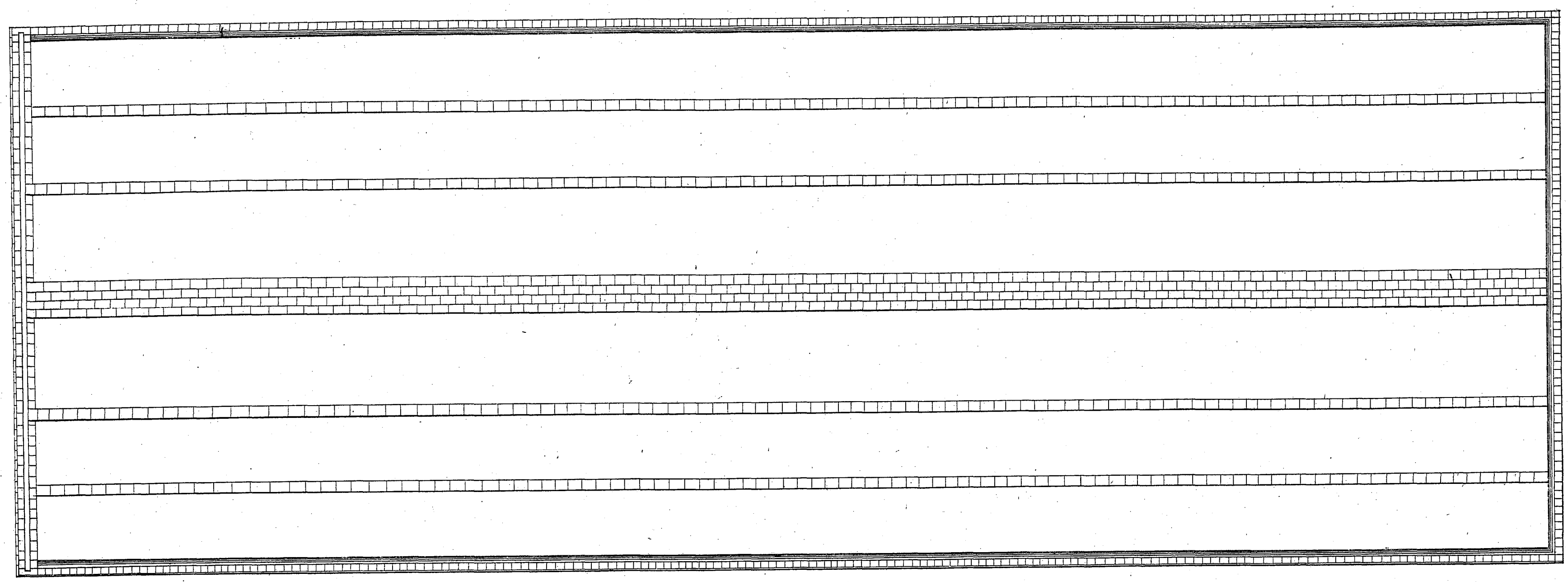
FIGURE TWO, shows a cross section of the basin, its foundation, including the piling for the same.

FIGURE THREE, is a plan of the floating gate of the basin.

FIGURE FOUR, is the elevation of the same.

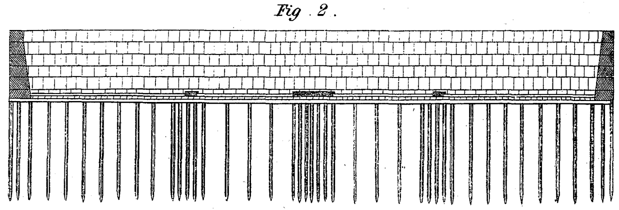
PLAN OF BASIN FOR THE BALANCE FLOATING DRY DOCK.

Fig. 1.



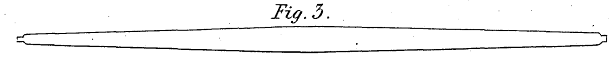
CROSS SECTION.

Fig. 2.



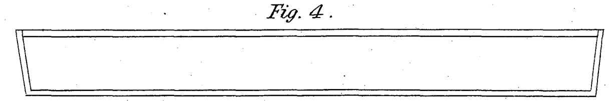
PLAN OF FLOATING GATE.

Fig. 3.



ELEVATION OF FLOATING GATE.

Fig. 4.



BALANCE FLOATING DRY DOCK.

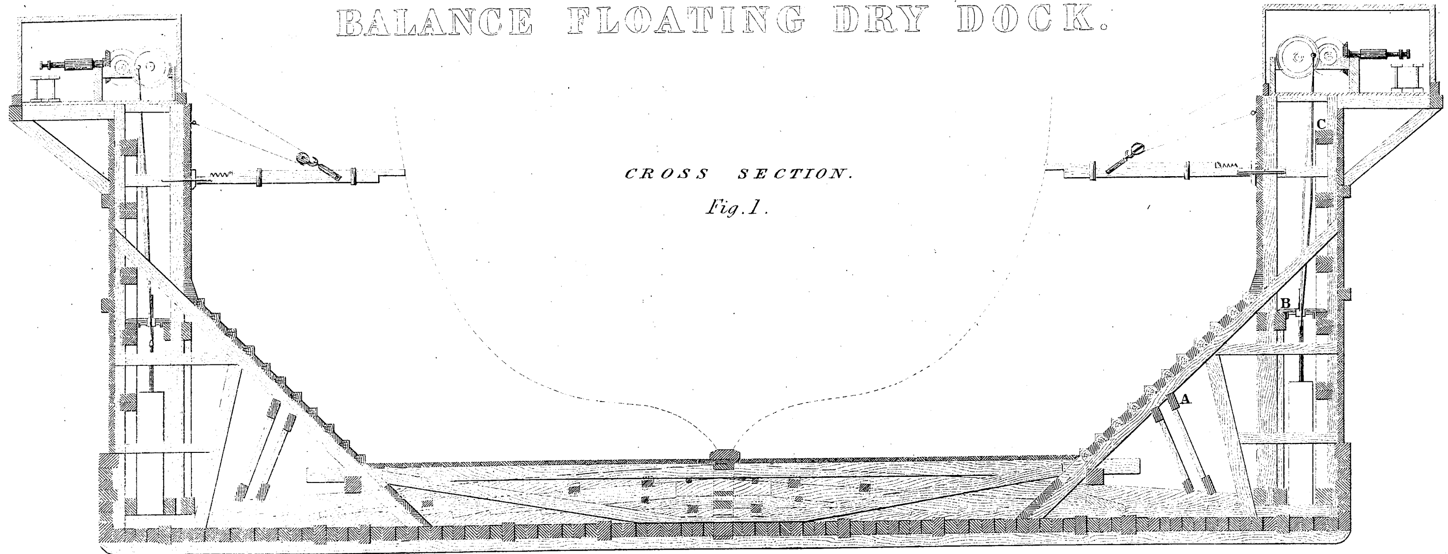
Description of PLATE NINE.

FIGURE ONE, exhibits a cross section, of the Balance Floating Dry Dock, with an outline of the stern of a vessel in dock, supported in its vertical position by bilge-blocks and hinge-shores on either side. On the top of the side frames is seen the machinery connected with the pumps used in this Dock.

FIGURE TWO, is an inner elevation of one half of the outer wall of the Dock, showing very distinctly the system of arching and trussing, adopted to give the requisite strength to the structure.

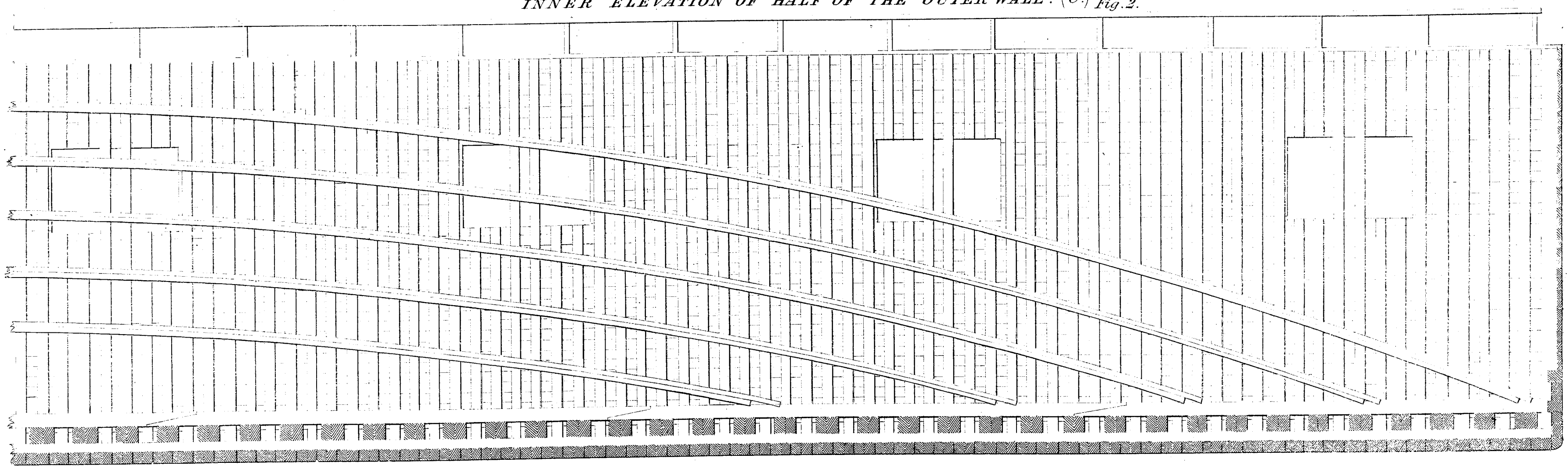
FIGURE THREE, shows an elevation of the truss work supporting the sloping ribs, marked on the section A, and also shows a section of the bottom, or flooring of the Dock.

BALANCE FLOATING DRY DOCK.

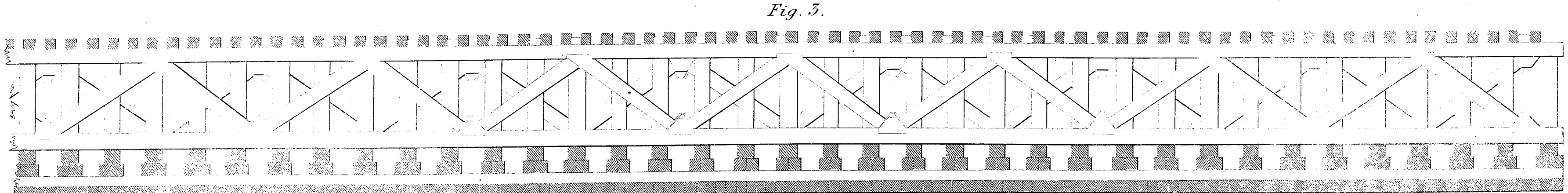


CROSS SECTION.
Fig. 1.

INNER ELEVATION OF HALF OF THE OUTER WALL. (C.) Fig. 2.



ELEVATION OF TRUSS WORK SUPPORTING SLOPING RIBS.(A.)
Fig. 3.



12 0 1 2 3 4 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 FEET.

A. Plinta C.E. "Stuarts" Naval Dry Docks of the United States. Engd. by W.L. Ormsby.

ELEVATION OF TRUSSES AND THE MACHINERY.

Description of PLATE TEN.

FIGURE ONE, is an inner or interior elevation of the upper chamber, and truss work, below the point B, marked on the section, Plate Nine, showing the windows in the side to admit light to facilitate the repairs of vessels.

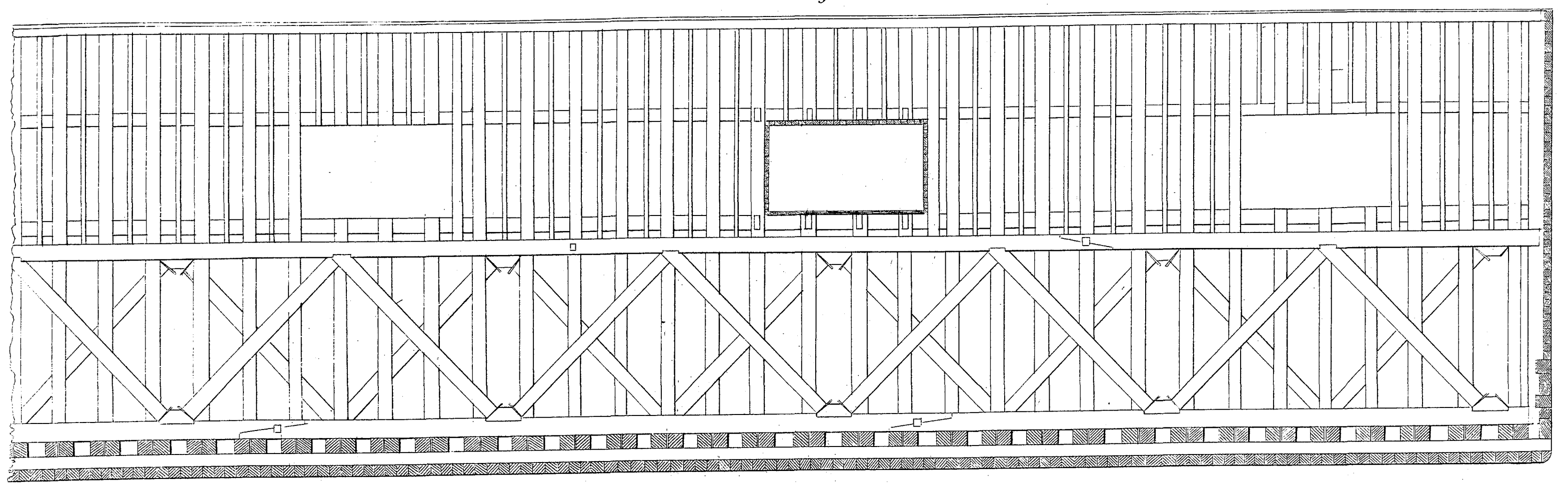
FIGURE TWO, shows the plan of the pumps, and the machinery connected with them, to pump the water into, and out of the chamber of the Dock.

FIGURE THREE, is an elevation of the same, on the line A B, of Figure Two.

ELEVATION OF TRUSSES AND MACHINERY.

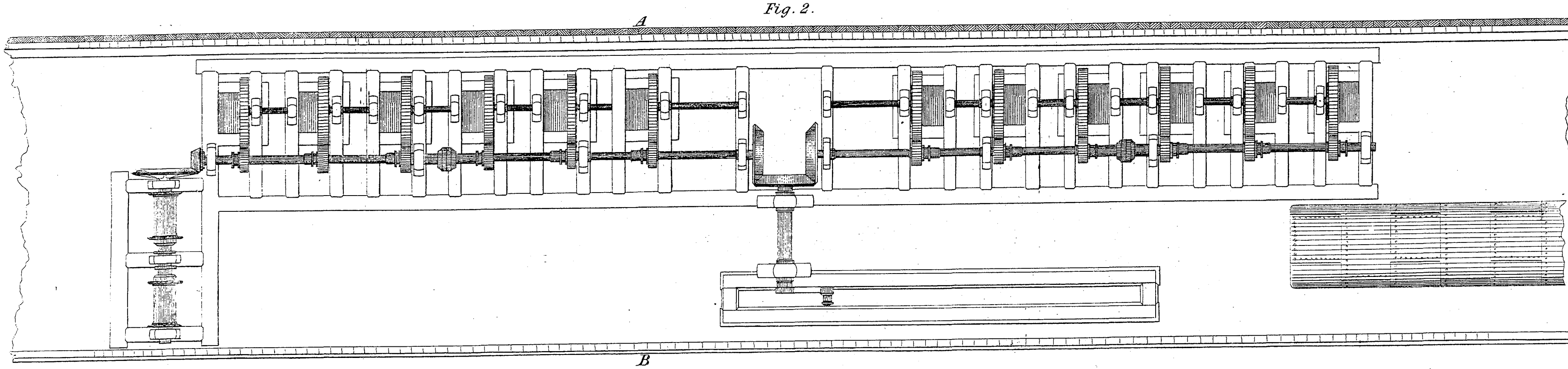
INNER ELEVATION OF THE UPPER CHAMBER & TRUSS WORK BELOW (B)

Fig. 1.



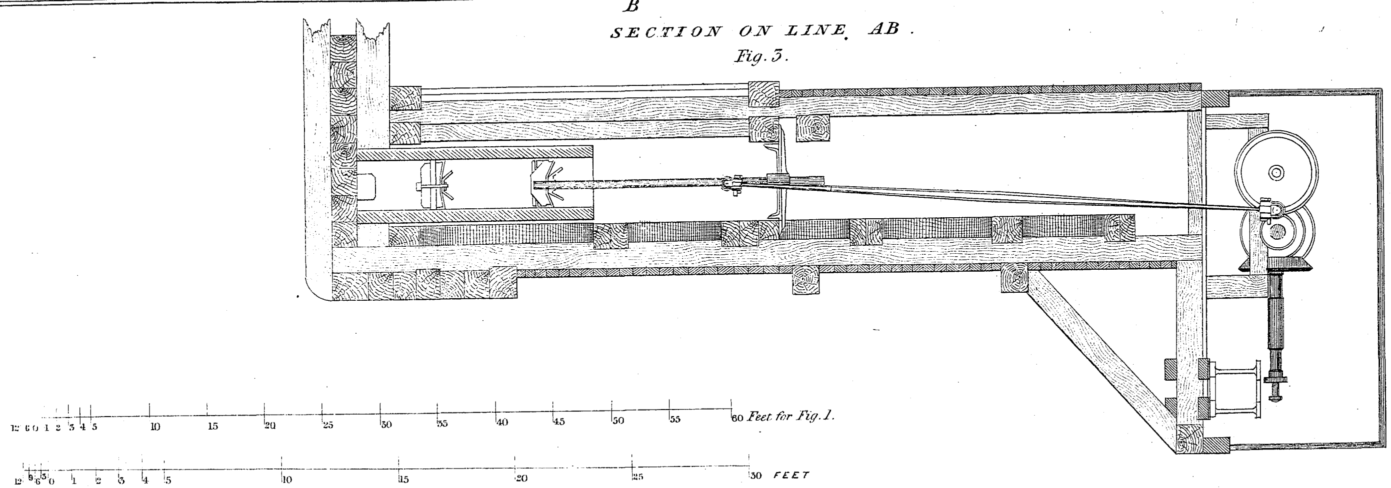
PLAN OF MACHINERY.

Fig. 2.



SECTION ON LINE AB.

Fig. 3.



PERSPECTIVE VIEW OF BALANCE DOCK.

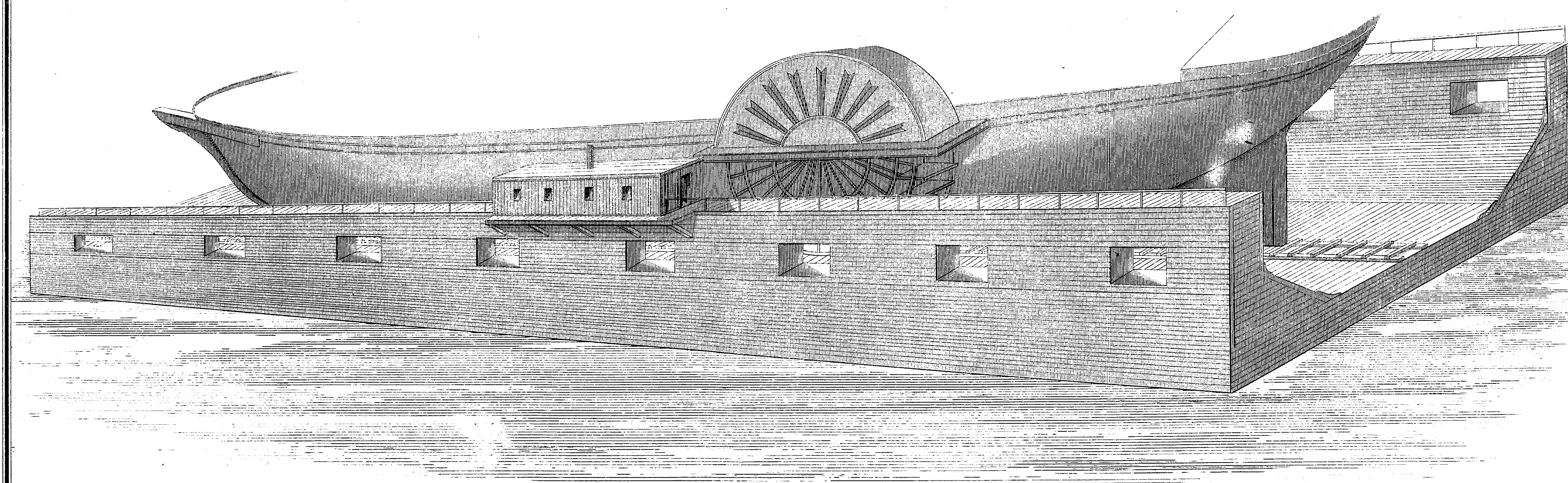
Description of Plate Eleven.

Figure One, exhibits a perspective view of the Balance Dock, at Portsmouth Navy Yard, with a steamer in dock, of the largest class. The small house in the centre covers the engine that works the pumps.

Figure Two, is a longitudinal section, and internal elevation of the same, in perspective, with the pump-chambers and keel-blocks.

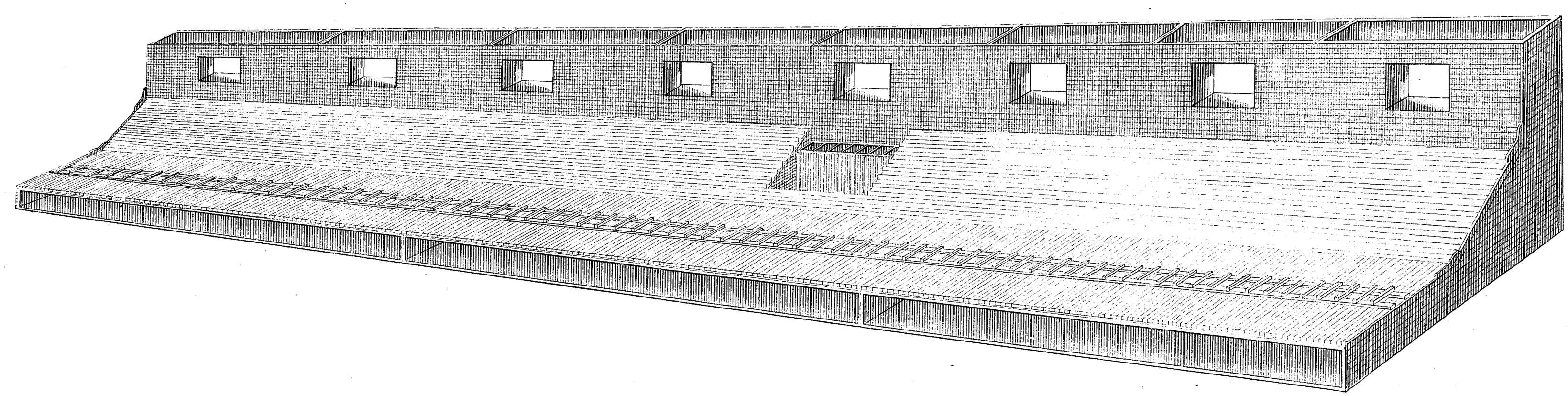
PERSPECTIVE VIEW OF BALANCE DOCK.

Fig. 1.



LONGITUDINAL SECTION & INTERNAL ELEVATION.

Fig. 2.



A. Plinta. C.E.

"Stuart's" Naval Dry Docks of the United States.

Engd. by W. L. Ormsby.

APPENDIX.

APPENDIX.

Note A.

The Basin.

THE bottom of the basin is three hundred and fifty feet long, and two hundred and twenty-six feet wide, and twelve and nine-twelfths feet from the surface of the floor to the top of the side and end walls, and so constructed as to have ten and nine-twelfths feet of water in the basin above the floor, at mean high tide. See Plate Three.

The manner of construction, and the materials used, may be described as follows, viz.: A Coffer Dam was first constructed around the site of the basin, of sufficient strength to exclude the water during the progress of the work. A tier of sheet piling of plank was then driven across the basin, eight feet from the front, leaving a space of eight feet in width between it and the front of the basin, along its whole width. Three rows of piles of hemlock, or other timber, twelve to fourteen inches in diameter at the butt, were driven within that space across the whole width of the basin, four feet from centre to centre, and on a line with those driven in the central part of the basin, and the said space between the sheet piling and the front of the basin was filled in from the bottom of the river, to the floor around the piles with concrete, forming a substantial wall eight feet thick in front of the basin. (See Plate Three, Figure Two.) The water was then pumped out, and the bottom of the basin was excavated, filled in, and levelled to the requisite depth, for the floor of the basin. Piles of hemlock, or other timber, twelve to fourteen inches in diameter at the butt, were then driven in rows, four feet from centre to centre, over the entire surface of the basin, and an additional row under the side and end walls, as shown in Plate Three. These piles were cut off level at the requisite depth, and capped with hemlock timber, twelve inches deep, and from twelve to fifteen inches wide, and fastened to the piles with treenails. The top of the piles, for forty feet from the front, were reduced to a uniform diameter, and the cap timbers were boxed on two inches, and locked on to their heads. The caps

were covered with six-inch hemlock plank, over the whole floor. The planks were spiked to the caps with iron spikes, eight inches long, one at each crossing, and two at the butts. The planking extends under the side walls. This floor was then covered with slabs of granite, nine inches thick, rough hammered on the top and edges, and laid in hydraulic cement. For the side walls, foundation hemlock timber, eight inches thick, for five feet in width, were laid upon the planking; and for the end or rear walls, foundation timber of hemlock, twelve inches thick, for five feet in width, was laid on the caps. The walls were laid on this foundation, twelve feet ten inches high, five feet thick at the bottom, and three feet thick at the top, bevelling back from the front, one inch to the foot, and reduced by offsets in the rear in each course, to diminish the thickness gradually to the top. The walls were constructed of granite, the face stone, and coping well cut with close joints. Each stone in the coping is of the width of the top of the wall.

The stone was all laid in hydraulic cement, and grouted, in regular courses, the two lower courses two feet thick, the others of eight inches. The backing of each course was of one or more thickness of stone, but no stone was used of less thickness than six inches.

The piles were driven, until a hammer weighing two thousand, two hundred and forty pounds, falling through thirty feet, would not drive them more than an inch at a blow.

APPENDIX.

Note B.

Railways and Slidingways.

The Bedways. There are two sets of bedways, commencing at the rear end of the basin, and running back into the yard, in the following manner, viz., each bedway consists of three ways (see Plate Three), one to support the keel, and two to support the bilges. Each bedway is three hundred and fifty feet long, and twenty-six wide, from outside to outside of the side or bilge ways. The earth was excavated to the requisite depth, three rows of yellow-pine piles, twelve to fourteen inches diameter, on the butt, were driven under the centre way, and two rows under each bilge-way, at a distance of three feet from the centres. These piles were driven until a hammer weighing two thousand, two hundred and forty pounds, falling through thirty feet, drove them but one inch at a blow. They were cut off level, three feet below ordinary high-water mark, and capped with white oak timber, twelve inches thick.

The caps of the centre ways were dovetailed to all the piles. A cross-tie timber, twenty-two feet long, of white oak, sixteen by sixteen, is put in every twenty-five feet, and locked down three inches on the heads of the piles, which they cross, and which are cut off five inches below the level. The top of the cross tie is boxed down four inches, to admit the caps which are gained in four inches, and the caps and tie locked together and treenailed. The tie is supported by one pile between each way. The walls under the bilge-ways are built of granite, laid in hydraulic cement, three feet thick at the bottom, and two and a half feet thick at the top, and three feet high. The wall of the centre way is also of granite, three and a half feet thick at the bottom and top, and two and a half feet high. The whole height of the bedway wall is laid with one course of stone. The beds, and vertical joints, and six inches from the top, down on each side, are rough hammered. The sides below were left in their rough split state.

Upon this foundation the bedways are laid, extending three hundred and fifty feet, from the rear of the basin into the yard, and are made of white-oak timber, in lengths of about fifty feet each. The bilge-ways are twenty-four inches wide, and eleven and a half inches high. The centre way is thirty-four inches wide, and eighteen inches deep. Three bedways, one centre and two bilge ways, are constructed to be placed under the ship in the Dock, connected with the ways laid in the yard, of the same dimensions and materials, except that the centre way is but eleven inches deep. The splices of the portion of the ways on the Dock, and the side ways on shore, are made by lapping the timber nine feet, and by a cogging four inches thick and three feet long, let two inches in each stick, secured by four, one and a quarter inches thick, iron screw-bolts. The ways are further secured by one and a quarter inches iron screw-bolts, every ten feet. The centre way, or hauling beam, is strengthened at the splices, with an iron bar three by twelve inches let in, and placed on each side, and keyed.

It is also bolted together, with one and a half inch iron bolts, one in every eight feet. A key-hole is mortised in every eight feet, to admit the key for holding the hydraulic cylinder.

THE *sliding ways, or cradle,* are three hundred and fifty feet long, and made of white-oak and yellow-pine timber, in six or seven lengths, and five or six splices. (See Plate Four, Figure One.) Each way is composed of two pieces of timber, fitted and bolted together. The side ways are twelve by twenty-four inches, and the centre way, twelve by thirty-five and a quarter. The cross beams are placed seventeen and a half feet apart, and have a cast-iron tenon bar that is let into the ways. The braces also have an iron tenon one inch thick, that sets into an iron mortise, made in the iron side bar. There are three sets of braces in the cradle, containing four each, making twelve in all. The sizes of the iron are as follows, viz., the two side bars, running from the head of the cradle, outside of the head braces, to a point five feet from the head of the bilge-way, are two by eight inches at the head of the cradle, and diminish gradually to three quarters by six inches at the foot.

Two iron bars, two by eight inches, run on each side of the centre way, from the head of the cradle to the first splice, from which point they diminish gradually to the lower end of the cradle. The nine bars will be spliced by caps and keys, one spliced on each side of the timber splices, at each end of the large bars. At the first cross beam, two iron bars, one and a half by six inches, cross the head of the ways, and are keyed, the lower one passing through the ways, and under the first cross beam, which is ten by fourteen. Iron rods, one and five-eighth inches in diameter, run through the ways, by the side of each cross beam, secured with nuts and screws. The iron keys on the plan are one by ten inches at the head, and at the first and second splice, and after the second splice, one by six inches, and all the iron screw-bolts are one inch. The inch cogging is let in between the timbers, as shown on the plan. A guide, four by seven, is bolted with one-inch bolts, one in every eight feet, on each side of the centre ways, and on the inside of the two side ways, and riveted together every foot; all of the several lengths of the timber are framed in the same manner as the first and second splices, and ironed as above stated. The cradle is so constructed as to be capable of being taken apart, and placed under the ship.

NOTE C.

Hydraulic Cylinder, Engine House, and Turn-tables.

The central bedways are to be extended forty feet from the end of the main ways, or three hundred and ninety feet from the rear of the basin, into the house hereinafter mentioned, built for the cylinder and boiler. The extension is constructed in the same manner as the main way, except that the piles are driven five feet, from centre to centre. On the bedways, an hydraulic cylinder of cast iron (see Plate Five), the piston of which is fifteen inches in diameter, and the stroke eight feet, is placed. The engines to work the pumps of the cylinder are placed near each end of the top of the cylinder, and consist of two vertical cylinders, sixteen inches in diameter, and sixteen inches stroke, with starting bars, and eccentrics. The cross heads are on a slide at right angles, and a connecting rod, which attaches the crank to the cross head, turns a shaft on which are the eccentrics, that work the force-pumps. There are four force-pumps, of one and a half inches diameter and six inches stroke. The connection between the pumps and hydraulic cylinder, is made by means of pipes and valves of suitable size and strength. The boiler to supply steam to the engines, is a locomotive boiler, having eighty-five tubes of two inches diameter, and nine feet long, giving a fire surface of 821.89 feet. The boiler is supported by a bed-plate of cast iron, resting on a bedway, and connected, by rods of iron, with the hydraulic cylinder under the boiler. On the top of the bedways is placed a reservoir, to furnish water to the boiler and the pumps of the hydraulic press.

The cross heads of the hydraulic press are of cast iron, fifty-seven inches long, thirty inches wide, and eighteen inches deep. Two side rods, five by eight, of wrought iron connect the cross head with the centre timbers of the cradle, on which the ship is to rest, when drawn on shore. The side rods are attached to the centre beams by two iron keys, eighteen inches wide, forty-six inches long, and six inches thick. The end of the side rods, and the centre timbers, are to have a mortise eighteen inches long, and six inches wide, to receive the keys; the keys are three, and six feet, from the ends of the centre timbers. To connect the hydraulic cylinder with the bedways; lugs are cast on the hydraulic cylinder, and mortises, six inches wide, two feet long, and eight feet apart from their centre, are mortised through the centre bedway. Cast-iron keys four feet long, are made of a proper size for the mortises. The ways are secured to the stone work by wrought-iron dogs. A house of brick is built for the protection of the cylinder and engine, over the end of the centre bedway, thirty-four feet in width, and forty-six feet long, and twelve feet high. The foundation is of cross foundation timber, four feet long, and five feet thick, laid in a trench dug three feet below the level of the surface of the ground. On the cross foundations ranging timber, twelve by twenty, is laid, and a stone wall is built up thereon, one foot above the level of the ground; a brick wall one foot thick is then built up twelve feet in height. The roof is laid to pitch both ways, planked and covered with ×× tin.

Two windows are placed on each side, and two in each end, and a door in front, and rear; and one, on one of the sides, of sufficient size to admit of the passage of the engine boilers. A turn-table is constructed near the end of each centre bedway, for the purpose of turning the cylinder round on the ways (see Plate Two, Figure Three), made in the following manner, viz., piles twelve inches in diameter are driven for the foundation, which are cut off three feet below mean high tide, and capped with timber, twelve inches thick, coped with stone. The frame of the turn-table is constructed of thick oak timber, twelve inches square; on the under side of it is a plate of iron, three quarters by six inches.

The turn-table runs on a centre pin, eight inches long, and eighteen inches diameter. The main ways are not laid over the space occupied by the table. Two pieces of white-oak timber, corresponding to the ways, are bolted together, and bolted to the turn-table. This timber, or short way, is placed on the table, and the pintal in the table passes up through the centre of the plate, and confines it in its position, and allows it to move round the pintal on centre plate, from one set of the ways to the other, for the purpose of removing the cylinders and engines from one to the other.

Temporary crossways may be laid down, when it is necessary to move the hydraulic cylinder frcm one end of the building to the other.

APPENDIX.

NOTE D.

The Floating Dock.

The Floating Dock consists of nine sections, each constructed in the same manner. The outside measurement of each section is as follows, viz.: one hundred and forty-eight feet long, and eleven feet deep; six of them thirty-two feet wide, and three of them thirty feet wide. The main tanks of the six sections are each one hundred and five feet long, thirty-two feet wide, and eleven feet deep; and the two end floats, each twenty-six and six-twelfths feet long, twenty feet wide, and eight and six-twelfths feet deep. The main tanks of the other three sections are each thirty feet wide, and of the same length and depth, as in the six sections, and the two end floats are each twenty-four and six-twelfths feet long, twenty feet wide, and eight and six-twelfths feet deep.

The sizes of all the timbers for the frame-work of the Dock are shown in Appendix, Note E, and Plates One and Two, and the frame-work was put together in the best manner, and in conformity to those plans.

The mode of construction was the same in each section, and as follows, viz.:—(see Plates One and Two,)

The two side trusses were first framed and put together in the following manner. Two sticks of white oak are spliced in the centre so as to make one piece; another stick of white oak is spliced at each end, near the steps of the trusses, to make the same length, and is placed on the top of the first stringer; two pair of trusses of white-oak timber are stepped into the main stringer. The float sill is placed on the top of the main stringer, running out to the end float frame, and bevelled to fit the foot of the truss. The two stringers, and the float sill and trusses, are then bolted together, with one and a half inch iron screw-bolts, two through each step; they being side by side, one only is shown on Plate One. The top stringer is then spliced together with one splice, and bolted with six one and a half inch iron screw-bolts. The short trusses near the end of the truss-frame, and the truss, are placed in position, and the corner posts are framed and halved on to the stringers, and bolted with one and a half inch iron screw-bolts. Mortises are made on the inside of the top and bottom stringers, to receive the top and bottom beams, half of yellow pine and half of white oak, and the side ribs of white oak are fitted and locked three inches on both edges of the top and bottom stringers and trusses. These ribs are each fastened with six five-eighths-inch iron spikes eleven inches long.

The truss frame is then strapped with two iron bands, each one by six inches, at the foot of each main truss, and one band of iron of same dimensions at the foot of each of the two smaller trusses, and four bands of iron one by six inches in the centre of the truss-frame. These bands are fastened in the centre, with keys and gibs, passing through a stud six by sixteen inches between the stringers, and holding the bands in place. The truss-frame being raised to an upright position, and a corresponding truss-frame being made and raised

for the opposite side of the section, the top and bottom beams, half of yellow pine and half of white oak, are framed with a double tenon, and inserted eighteen inches from centre to centre, in the mortises made in the top and bottom stringers to receive them, and pinned. Two interior trusses of white-oak timber, are framed and set up in their position. The ties are spiked with two iron spikes, nine inches long, and seven-sixteenths inch square, in each keelson, and one at each crossing of the trusses and end braces.

One cross truss of white-oak timber, is framed within the tank under the keel. The bottom stringer or beam is checked on one corner, six inches, to admit the bottom keelsons, and the ends rest upon the two side stringers, and mortise into a side rib. The top stringer mortises into the top side stringers. The trusses are fastened with two one and a half inch iron bolts. The studs are also framed in an upright position in this truss. The end corner beams are framed into the side stringers, and the end studs of white oak are framed into the end, top and bottom beams of the main tank, the studs being tenoned into the corner beams, and fastened with pins.

A double water-tight bulkhead is constructed in the centre of the tank, on each side of the interior truss. This bulkhead is made of two tiers of white-oak plank, standing endways, four inches thick, and fitting in a rabbet on the bottom beam and the top truss-beam. Each plank is fastened with seven-inch iron spikes, two at top and two at bottom, to these beams and to each side of the truss, with two similar spikes in each plank. A space is left in one tier of the plank, to allow the water to escape. Two bulkheads made of two-inch white-pine plank, are framed inside of the tank, at equal distances from the centre to the end, and are secured by being spiked to the top and bottom beams with four-inch iron spikes, and a plank three by ten inches is fitted between the bulkhead and adjoining beam. Each of the bulkheads, except the centre one, is provided with a door, to admit of passing from one apartment to the next.

Two connecting rod posts of white oak are framed in the side truss-frame, near each corner of the section, in the same manner as the side ribs. The end corner beams, and corner posts, are rabbeted to admit of planking, flush with the outside of the posts and beams. The four corners, on the two sides, are worked out of oak and yellow pine, and gained into the side ribs and against the stringers, forming the commencement of the planking, and making no joint at the corners.

The planking on the bottom of the tank, is four inches thick; on the ends four inches thick; on the top three and a half inches thick; and on the sides five inches thick, of white oak on the bottom and ends, and the rest of yellow pine. The plank used is twelve inches wide above the centre of the tank, and not over fifteen inches wide below the centre. Each plank is fastened with two iron spikes, nine inches long, and seven-sixteenths inch square, to each beam at the crossing. On the top of the tank the plank are fastened with iron spikes, seven inches long, and three-eighths inch square, driven at the same distance apart, and in like manner. On the sides of the tanks the plank are fastened with two iron spikes, ten inches long, and nine-sixteenths inch square, and also by one iron spike of same size to every third rib, and by two treenails one and a quarter inch to each crossing, for each plank, except where the spikes were driven. The ribs on the sides of the main tank, are each fastened with two iron spikes, eleven inches long, and five-eighths inch square at top and bottom stringer, and also by one in the trusses at each crossing, and two in each stud in the float sill.

The main tank is thoroughly caulked, tarred, pitched, and made water-tight, and is sheathed with seven-eighths inch white-pine boards, laid lengthways of the section, fastened with three-inch zinc nails, three to every two superficial feet. The sheathing is then graved, with a coat of tar and pitch.

The end frames are constructed as follows:—The posts of oak are mortised down through the top and bottom stringer, and secured by locust pins. The posts of the adjoining section are mortised into the float sill, close to the end of the section, and halved on, and pinned thereto, and bolted to the end beams of the main tank, with two one and a quarter inch bolts in the beam, and two pins in the sill.

The posts in the out end section, are mortised into the float sill, and bolted with one bolt. The pinion posts of white oak are tenoned into the float sill, and the girts above. The girt is mortised, to receive the segment posts, and halved on, and bolted with one and a quarter inch screw-bolts, to the posts. The main brace and posts last named having been halved or boxed, at the intersecting points, are then bolted with one and a quarter inch iron screw-bolts, two at each crossing. The girt is then halved on to the posts, and fastened at each crossing with one and a quarter inch iron screw-bolts. The brace is halved on to the float sill, and fastened with two one and a quarter inch iron screw-bolts, and also to the post with similar bolts. The brace is halved on to the float sill and girt, and bolted with similar bolts. A corresponding frame is then raised on the truss-frame, and float sill, on the opposite side of the section. The four braces having been framed and tenoned into their places, together with the girts and braces, and bolted with one and a quarter inch joint-bolts, the floor beams are laid on the girts, and secured by pins. A girder is then raised, and secured by screw-bolts to girts, and supported by a post. A floor is then laid on the floor beams, of two-inch white-pine plank, jointed together and secured with two four-inch spikes, at each crossing.

A house, fifteen by twenty feet, is then constructed on the top of each end frame, seven feet in height, to protect the machinery. The frame-work and rafters are of white-pine scantling, covered with seven-eighths inch white-pine boards, six to eight inches wide, planed on both sides, matched and grooved, and the roof is covered with matched one and a quarter inch pine plank, and × × tin. A ladder is constructed to go from the deck to the platform, in each end frame, upon one of the inner braces.

The End Floats.

There are two end floats on each section, the frames of which are of oak and yellow-pine timber.

The top and bottom beams are tenoned with single mortises, into the side corner beams. The side studs are also mortised with single mortises, into the end corners. Two yellow-pine keelsons are tenoned into the keelson posts, in the end floats. Studs of yellow pine are set between the keelsons, three feet apart. The outside corners have a rabbet, to admit the plank flush with the corners. The end floats are covered with three-inch yellow-pine plank, fastened with six-inch wrought-iron spikes, three-eighths inch square, two to each beam, at the crossing for each plank. No plank are used over twelve inches wide, and on top not over ten inches wide. The corner posts are secured with iron joint-bolts, one and a half inch diameter, and the tenons

are pinned. Eight braces are framed in each end of the main tank, stepping into a girt, and the two centre top and bottom keelsons.

The end floats are caulked, tarred, pitched, and made water-tight, and their bottoms, sides, and ends are sheathed, four feet from bottom, with seven-eighths inch white-pine boards, well jointed, fastened with three-inch zinc nails, three to every two superficial feet. The sheathing is graved with a coat of tar and pitch.

The end floats are rolled into their places, between the side posts at the ends of the section. Guides are spiked to the posts with eight-inch spikes; and guides are spiked to the four corners of the floats, to guide them in their ascent and descent.

Two pieces of white-oak timber, one at each end of the section, are fastened on the top of the section, and a mortise is made on each side, to receive the tenon of the connecting beams.

Two connecting beams are framed and inserted between the connecting rod posts, under the key, and tenoned into the timbers. The connecting rod timbers are secured together by two iron bolts.

There are two keel-block timbers of white oak, laid side by side, and fastened to the top of the dock, with eight fifteen-inch iron spikes. The four slides for the bilge-blocks to rest upon, of white oak, are placed directly over the trusses, and fastened down with iron spikes, fifteen inches long, and five-eighths inch square, and four feet apart. There are eight keel-blocks to each section, three feet long, and twelve by eighteen inches, of white oak, fastened down with iron dogs, two in each. There are also eight bilge-blocks, made of white oak, of the following sizes, viz:—Three, five feet high, and two, eight feet high; four of them five feet long at the base, and four, five and a half feet long at base; and all one foot thick at bottom, and eight inches at top. They are secured to the bilge-block timbers, by iron guides, and provided with iron racks bolted to the bilge-slides, six inches wide, and one inch thick, with suitable followers or falls, hung at the foot of each block with hinges, and every thing complete for working them.

The top of the platform, not covered with the houses, is protected with zinc. Every part of the Dock above the water is well painted with three coats of zinc paint.

Each section is furnished with two air-tubes, seven inches square, of white-pine boards, running from the tank to the platform, graduated to feet and inches, to show the sinking of the Dock, and with two gauge rods and copper plates within them, marked and graduated, to show at all times the lifting power exerted by the Dock; also, with four wale-shores, provided with racks and pawls, hinges, and lines for working; and also, with six composition pumps of eleven inches bore, with butterfly valves; and each provided with one and a quarter inch iron rod, leading to the cross-head and slides, and connecting with the pump-shaft or crank, to which is attached a fly-wheel, moved by a belt running from the main shaft.

Four steam-engines, with locomotive boilers, two of twenty-horse power each, and two of twelve-horse power each, of the best construction, are used for driving the machinery.

A composition gate is placed in each end of the main tank, with a connecting rod leading to the platform.

A plug-hole, one and a half inch in diameter, is made in the bottom of the tank, nearly under the scuttle, with a suitable plug and handle, to admit water the first time the Dock is sunk.

A scuttle is placed at each end of the main tank, of sufficient size to admit of passing into the interior

with a ladder, leading to the bottom of the tank, provided with an appropriate covering of the same thickness as the planking, and caulked down water-tight.

Each section is also provided with all the requisite pump and float machinery and gearing.

All the shafts are of wrought iron, of appropriate sizes and bearings, and all the cog-wheels, racks, and pinions are of cast iron.

For list of machinery, for each section, refer to Appendix, Note F.

NOTE E.

Bill of Timber in One Section of Dock.

No. Pieces.	FOR WHAT PURPOSE.	Length.	Dimensions.	No. Pieces.	FOR WHAT PURPOSE.	Length.	Dimensions.
	White Oak.	Feet.	Inches.		*White Oak.*	Feet.	Inches.
4	Shoes - - - - -	56	8 × 16	8	Posts - - - - -	45	10 × 10
2	Bottom Stringers - -	75	16 × 16	4	Braces - - - - -	28	8 × 15
4	End Splices - - - -	24	16 × 16	4	" - - - - - -	$27\frac{6}{12}$	8 × 9
4	Float Sills - - - -	$45\frac{6}{12}$	16 × 16	4	" - - - - - -	11	6 × 7
2	Top Stringers - - - -	65	16 × 16	2	Girts - - - - -	30	10 × 12
2	" " - - - -	45	16 × 16	2	" - - - - - -	30	7 × 14
4	Trusses - - - - -	35	16 × 21	2	" - - - - - -	30	6 × 14
4	" - - - - - -	20	16 × 16	4	" - - - - - -	26	8 × 15
4	" - - - - - -	24	5 × 12	4	Plates - - - - -	26	12 × 12
4	End Trusses - - - -	15	5 × 12	4	Shore Beams - - - -	32	6 × 18
4	" " - - - -	16	10 × 14	8	Bilge-Block Slides - -	46	6 × 18
4	Keelsons - - - - -	70	14 × 15	4	Connecting Rods - -	33	7 × 16
8	" - - - -	25	14 × 15	2	" Rod Blocks -	$4\frac{6}{12}$	16 × 19
4	" - - - -	30	7 × 15	2	Brace Sills - - - -	6	8 × 9
4	" - - - -	$18\frac{6}{12}$	9 × 12	8	Keel-Blocks - - - -	3	12 × 18
8	" - - - -	16	8 × 12	8	" " - - - -	2	6 × 18
1	Beam - - - - -	31	16 × 16	8	Shores - - - - -	19	6 × $6\frac{1}{2}$
1	" - - - - - -	$28\frac{6}{12}$	16 × 24	8	Bilge-Blocks - - - -	6	12 × 72
1	" - - - - - -	$28\frac{6}{12}$	14 × 24	4	Float Corners - - -	20	12 × 15
4	Trusses - - - - -	30	9 × 15	8	Posts - - - - -	$8\frac{9}{12}$	12 × 12
2	" - - - - - -	$15\frac{6}{12}$	12 × 16	4	Keelsons - - - - -	$26\frac{6}{12}$	6 × 9
4	" - - - - - -	$15\frac{6}{12}$	6 × 16		*Yellow Pine.*		
4	Corners - - - - -	31	14 × 18	124	Beams - - - - -	$28\frac{6}{12}$	6 × 14
2	End Beams - - - -	31	12 × 14	8	Posts - - - - -	46	10 × 15
16	End Braces - - - -	7	7 × 9	8	" - - - - - -	36	6 × 7
4	Corners - - - - -	60	12 × 14	4	" - - - - - -	28	6 × 7
4	" - - - - - -	45	12 × 14	16	Top Beams - - - -	30	6 × 12
4	Beams - - - - -	$28\frac{6}{12}$	6 × 14	8	Float Corners - - - -	$26\frac{6}{12}$	11 × 11
120	Ribs - - -	$10\frac{6}{12}$	9 × 9	4	" " - - - -	20	11 × 11
30	End Studs - - - -	10	6 × 14	24	Studs - - - - -	5	6 × 6
4	Keelson Studs - - - -	10	14 × 14	8	" - - - - - -	$7\frac{6}{12}$	6 × 9
88	Ties - - - - -	$10\frac{6}{12}$	7 × 12	94	" - - - - - -	$7\frac{6}{12}$	5 × 9
8	Corner Posts - - - -	15	12 × 12	56	" - - - - - -	19	5 × 9
4	Posts - -	48	10 × 15	2	" - - - - - -	19	9 × 9

APPENDIX.

PLANK.

White Oak.

4 inch Bottom Plank	15,900 feet B. M.
4 inch End Plank	2,520 " " "
4 inch Bulkhead Plank	3,250 " " "

Yellow Pine.

$3\frac{1}{2}$ inch Top Plank	12,048 feet B. M.
5 inch Side Plank	10,815 " " "
$3\frac{1}{2}$ inch Float Plank	22,668 " " "

White Pine.

2 inch Bulkhead Plank	2,250 feet B. M.
2 inch Top of Platform Plank	3,712 " " "
1 inch Sheathing Boards	13,000 " " "
1 inch Siding of Engine House	2,200 " " "
4 inch Scantling in Engine House	1,000 " " "

Note F.

List of Machinery for One *Section Floating Dock, Philadelphia Navy Yard.*

80 large Rack Segments.
8 Pinions.
16 Straps for same.
16 Brasses.
8 Rollers.
16 Bearings.
16 Gibs and Keys.
16 Bolts.
4 Shafts (float).
12 Pillow-Blocks.
24 Bolts for same.
4 Spur Wheels.
2 Screw-Wheel Shafts.
4 Pillow-Blocks.
8 Bolts.
3 Spur Wheels.
2 Screw Wheels.
2 Screws.
2 Screw Shafts.
4 Bearings for same.
4 Washers and Collars.
4 brass Washers.
2 Frames, complete.
48 Bolts for same.
2 Bevel Gear Frames.
20 Bolts for same.
4 Bevel Wheels.
2 Hollow Shafts with Friction Rollers.
2 Clutch Levers and Rods.
2 Vertical Shafts.
2 Pillow-Blocks for same.
2 brass Washers.
12 Bolts for same.
4 Bevel Wheels.
2 Gear Shafts.
4 Collars for same.
2 Clutches.
2 Clutch Levers.
2 Stands for same.
10 Bolts.
8 Spur Wheels.
2 double Stands.
2 single Stands.
28 Bolts for same.
2 Driving Shafts.
4 Stands for same.
24 Bolts for same.
4 Connecting Sockets.
4 Rings for ends of same.
24 Bolts for same.
4 Pulleys.
4 Clutches for same.
16 Bolts for same.
4 Clutch Levers.
4 Stands for same.
4 Weights for same.
12 Bolts for same.
8 Collars.
2 Connecting Shafts.
4 Cross-Heads for same.
2 single crank Pump Shafts.
2 double crank Pump Shafts.
4 Fly Wheels.
8 Pillow-Block Stands.
48 Bolts for same.
4 Pulleys.
6 Connecting Rods, complete.
6 Cross-Heads.
24 Gib Brasses for same.
6 forked-end Pump Rods.
12 Slides.
48 Bolts for same.
70 Bilge-Block Segments.
30 Wale-Shore Segments.
2 Gates, Strainers and Sprigs.
2 Copper Rods for same.
6 Pump Chambers.
12 Pump Valves.
48 Bolts for same.
4 Air-Valves.
6 Pump Pipes.
Main Frames.
End Frames.
8 patent iron Strap-Blocks.
7 $\frac{7}{8}''$ Sheaves, lig. vit. pins, $6\frac{1}{2}'' \times \frac{5}{8}''$.
6 $\frac{5}{8}''$ Sheaves, lig. vit. pins, $6'' \times 1\frac{1}{8}''$.
4 Belts, $13'\ 3'' \times 8'' \times \frac{3}{16}''$.
6 Chains, $\frac{5}{16}''$ wire, 40′.
95 fathoms Man-Rope, 3″ B. Blocks.
123 fathoms Man-Rope, $2\frac{3}{4}''$ W. Shores.
200 pounds assorted cut Nails.
2400 feet Wedges, $5\frac{1}{2}''$ long $\times$ 3″ wide.
7100 feet Wedges, 4″ long $\times$ $3\frac{1}{2}''$ wide.
800 Treenails.
8006 pounds Bolts.
7000 pounds Spikes.
670 pounds Roofing Tin.
200 pounds Oakum.
5 barrels Tar.
3 barrels Pitch.
150 pounds Paint.

For NINE *Sections of Philadelphia Dock.*

2 twenty-horse Engines and Boilers.	64 Eye-Bolts.	33 Straps, Bolts and Staples, W. Shores.
2 twelve-horse Engines and Boilers.	64 Pawls, W. Shore.	225 Straps, straight, B. Blocks.
4 Water Tanks.	64 $\frac{1}{2}''$ sq. Bands, W. Shores.	224 Straps, bent, B. Blocks.
432 large Truss Straps.	33 Straps with Bolts, W. Shores.	64 Pawls, B. Blocks.

Summary of the Weight of Machinery (proper) for ONE *Section.*

49,079 pounds Cast-Iron Work.
14,840 pounds Wrought-Iron Work.
2,538 pounds Composition Work.

NOTE G.

Lifting Power and Weight of Dock.

6 Sections	105′	× 32′	× 11	× 64 lbs.	÷ 2240 lbs.	=	6,336	tons.
3 Sections	105′	× 30′	× 11	× 64 "	÷ 2240 "	=	2,970	"
6 End Floats	$26\frac{1}{2}$	× 20	× $5\frac{1}{2}$	× 64 "	÷ 2240 "	=	500	"
3 End Floats	$24\frac{1}{2}$	× 20	× $5\frac{1}{2}$	× 64 "	÷ 2240 "	=	231	"
					Displacement		10,037	tons.

95,388 cubic feet White-Oak Timber, 60 lbs.	=	2,555 tons.
48,807 cubic feet Yellow-Pine Timber, 49 "	=	1,060 "
14,850 cubic feet White-Pine Timber, 35 "	=	233 "
Machinery	=	267 "
Engines, Boilers, and Iron-Work	=	30 "
		4,145 tons.
Lifting Power of Dock		5,892 tons.

NOTE H.

Dimensions.

THE outside dimensions are three hundred and fifty feet in length, and one hundred and five feet four inches in breadth, the depth being thirty-eight feet three inches. The foundation is composed of three layers of timbers; the two lower ones are each one foot square, and each made tight, independent of the other. The course of timber which forms the first or lowest layer of the platform, is made in three lengths. The first begins with a piece of forty-five feet, then one of forty feet four inches, and then one of thirty feet. The second course begins with a piece of thirty-five feet, then another of thirty-five feet, and then one of forty-five feet four inches. The third course begins with a piece of sixty feet, and then one of fifty feet four inches. These dimensions are repeated throughout the length of the Dock. They have five feet vertical scarfs, each scarf having four and seven-eighths inch copper butt-bolts, two feet long. Each course is treenailed laterally with one and three-eighths inch locust; the treenails being two feet apart, fox-wedged, and reaching in two feet. Every seam in this platform is made about three-eighths of an inch, and then caulked from above with wedges of soft wood extending down four inches into every seam, making it a water-tight platform. The top of this layer is covered with felt laid in tar.

Fastening.

The next, or middle layer, runs not transversely as before, but longitudinally; it is composed of scarf-pieces of from thirty to forty-five feet in length, the scarfs in this layer being keyed. Each course is treenailed laterally every two feet, and down through and through with one and three-eighths-inch locust, two feet apart, like the first layer; it is then caulked with wedges of soft wood. This course, as well as the one below, is of twelve-inch square timber, except ten of the courses, which are twelve inches broad, and eighteen inches deep, and the middle course, which is sixteen inches broad, and twenty-four deep; they may be termed keelsons. They jog down into the lower layer three inches, along the whole length of the platform, and also project above three inches. The third, or upper layer of timbers, are sixteen inches deep, by twenty-eight inches broad; they are composed of two courses of timber, side by side, each fourteen inches broad, and sixteen inches deep, locked, scarfed, keyed with live oak, ten keys in each beam, eight inches square, reaching down through. They are screw-bolted together with inch iron, one bolt being four feet, and jogged over the said projections of the longitudinal courses; they are placed four feet apart from centres, and bolted down through and through with seven-eighths copper bolts, two feet apart, and clinched. They form the lower part of the truss-beam, being Gilbert's patent clamp bottom.

APPENDIX.

The Thick-Work.

The sides and ends are built up as far as eight and a half feet high with thick strakes, the lower course all around being eighteen inches deep by twelve inches thick, and is copper bolted with seven-eighths-inch bolts, one foot apart, down through and through the lower courses of the platform, and clinched.

The next two courses all around of this thick-work is twelve by twelve; the next course twelve by fifteen, and jogged three inches into the outer ribs; then again two courses of twelve by twelve, and one twelve by fifteen, jogged in as before. Each of these courses is bolted down to those below it, with inch iron bolts, three feet apart, extending down three feet; the sides and ends thus far up are caulked inside and out with wedges of soft wood.

The whole under surface, and the sides and ends, four and a half feet high, is covered with felt laid in tar, and sheathed with thirty-two ounce copper, fastened on with one and a half inch composition nails.

The Trussed Floor-Timbers.

They are made in that form which may be termed double solid truss-beams, the lower truss being sixteen inches square, the inner ends laying on a chock fourteen inches deep; this truss rises above the tight platform four feet at the middle line of the Dock; the upper one is sixteen by eighteen deep, making the depth of dock bottom seven and a half feet. They are placed four feet apart from centres, making eighty-seven in the whole length of the Dock. Between each truss-beam, and along the middle of the Dock, there is an iron cramp-band, five inches wide by three-fourths of an inch thick, passing over a keelson formed of four pieces, extending from the platform up to the line of the upper truss, running the whole length of the Dock and halved into the trusses. These bands pass down to the tight platform, and are bolted through the keelsons with inch iron screw-bolts, one through each course. Each of the courses which form the keelsons, is separately fastened one upon another with inch iron bolts reaching down three feet, except the lower piece, which is fastened with seven-eighths copper bolts down twenty inches into the tight platform, there being two bolts through each truss-beam and one between. The several parts of each truss, and the chocks below them, are separately bolted down through the parts below with inch iron bolts, three feet apart diagonally, the bolts passing through all the parts down to the tight platform. Two of the beams, each of them one hundred feet from the end of the Dock, are caulked, making a tank of one hundred and fifty feet long across the middle of the Dock.

Outer Ribs.

The outer ribs of the sides and ends of the dock chambers are twelve by twelve inch timber, except the corner posts, which are twenty-four by twenty-four inches, placed one foot apart, in the clear. They are hook-tenoned into the ends of the lower pieces of the truss-beams, and fastened with two one-inch iron screw-bolts passing through the beam and tenon, and are also fastened, through the thick-work of the sides and ends, with one and three-eighths locust treenails, two treenails in each rib. The thick-work is also butt-bolted through and clinched, with seven-eighths-inch copper bolts, four bolts in each scarf. The ribs are also supported at their heels by stringers, sixteen inches square, jogged two inches into each rib, and fastened by two one-inch copper bolts in each truss-beam, reaching down twenty-one inches into the tight platform.

This outer wall is also supported by a series of five parallel arches, made in two thicknesses of eight by sixteen inch plank and jogged into the outer ribs three inches, the lower ends of the arches being jogged into the stringer, and fastened with one iron screw-bolt and two blunt bolts at each end.

The arches are also fastened through the outer ribs with one and a quarter locust treenails, one in every alternate rib. Each of the outer ribs which are cut off by the windows, are fastened to thick strakes, twelve by twelve, running along the outside of the Dock, with a seven-eighths-inch iron screw-bolt; and that part of the arch which crosses the windows, is fastened with screw-bolts of the same size, at distances of three feet apart. One half of the side outer ribs pass down between the truss-beams to the tight platform, and are dovetailed into the fore-and-aft stringer, to which they are fastened with one-inch iron bolts.

Sloping Ribs.

The inner ribs that form the frames of the sloping sides of the chambers, are twelve by twelve inch timber; they start from the tight platform at a distance of twenty-five and a half feet from the middle of the Dock, and pass up on an angle of forty-five degrees, the upper ends passing between the outer ribs, to which they are fastened with an inch iron screw-bolt like the latter; they are one foot apart, secured at their lower ends to the truss-beams by a hook dovetail, jogged sixteen inches into the lower part of the truss-beam; they have a shoulder of two inches that rests upon the tops of the truss-beams, clamping its several parts together, four screw-bolts of inch iron passing through the dovetails, one through each part of the truss-beams; they are backed at their heels by a stringer sixteen inches square, running along on the top of the truss-beams, within the chambers, fastened with two iron inch bolts in each truss-beam reaching down to the platform.

They are also supported in front by stringers, sixteen by twenty-four, bolted along the middle compartment of the Dock, fastened in the same way as the other. They are also backed and supported by a sloping stanchion, twelve by sixteen, tenoned into the top of the truss-beam, and passing up between two of them,

supporting them on shoulders of two inches, and fastened by an inch iron screw-bolt reaching through and through two ribs.

On each side of the heels and shoulders of the stanchions there are eight by sixteen inch clamps, bolted upon the top of the truss-beams with an inch iron bolt in each beam, and with the same above into the sloping ribs. These clamps are in lengths of thirty to fifty feet, and key-scarfed, the scarf being screw-bolted; they are also fastened to the stanchions by screw-bolts of seven-eighths iron, and passing through and through each of them. There is a system of truss-work connected with these stanchions and stringers, running the whole length of the Dock. It is composed of scantling, six by sixteen, jogged into the stanchions two inches, and bolted together with iron screw-bolts, seven-eighths-inch framing passing through and through the trusses and stanchions where they cross. The trusses are keyed up with white-oak wedges upon an oak chock

Upper Chambers.

The upper chambers are seven feet four inches wide at the top; their frames consist of the outer ribs of the Dock as already described; the inner frame is formed of upright stanchions, twelve by twelve; these stanchions pass up between every alternate sloping rib of the chamber; they are tenoned into the trussed beam, the tenon being eight by twelve, and fastened by a screw-bolt of inch iron reaching through the beam.

They are also supported on both sides, when they pass between the sloping ribs, by clamps nine by sixteen, and also by clamps at their heels of twelve by sixteen. The clamps are in lengths of thirty by sixty, and key-scarfed, the scarfs being fastened with inch iron screw-bolts. These clamps are jogged into the stanchions two inches, and fastened by inch iron screw-bolts passing through each stanchion. The lower clamps are fastened to the truss-beam by two one-inch iron bolts in each beam, reaching down to the platform.

Between these upper and lower clamps, and connected with the stanchions, there is a system of truss-work of eight by sixteen scantling, jogged into the stanchions two inches, and fastened by inch iron screw-bolts, passing through where the trusses cross the stanchions; it is keyed up at the ends against oak chocks. There is a twelve by twelve plate tenoned along the top ends of the stanchions, fastened by two one and a quarter inch locust treenails passing through each tenon.

There is also a clamp, ten by sixteen, on the back of these stanchions, running along under the sloping ribs; it is screw-bolted through the stanchions, and bolted to the sloping ribs with inch iron, one bolt in each stanchion and rib. Between each of these twelve by twelve stanchions, there is a stanchion, six by twelve, extending from between the clamps up to the plate of the chambers; it is fastened at its heel with seven-eighths screw-bolts, and is tenoned into the under side of the plate and fastened with a treenail. Each cross-frame of the side chambers being thus composed of the outer ribs, the sloping ribs and the stanchion of the upper chamber is supported by a twelve by twelve inclined stanchion, halved on the side of the truss-beam near its end, and passing up under the sloping rib, midway between the two lines of trussing, is fastened with two bolts of inch iron at both ends.

There are two twelve by twelve horizontal beams across each frame, and fastened to the outer ribs and to the stanchions of the upper chambers, with iron inch bolts, and extending across the chambers to the inclined stanchions, bracing the lower chambers in two places every four feet along its whole length, as equally distant as the arches and truss-work will permit. There is a twelve by twelve beam across the upper chambers, five feet below the deck, fastened with seven-eighths-inch iron screw-bolts. There are eighty-seven of these frames in each of the side chambers.

Transverse Bulkheads in Chambers.

Across each of the side chambers there are ten tight bulkheads, three of them at each end, and are thirty-eight feet apart. The main pump-well, in the middle of the chamber, is forty-six feet, and the two smaller pump-wells, in each chamber, about six feet. These bulkheads are made of six-inch plank as far up as the lower chamber, and above that height—reaching up to the tops of the chambers—thirteen of four-inch plank, fastened to the frames of the lower chambers with seven-eighths-inch bolts, and above with ten-inch iron spikes. The level of the Dock, longitudinally, is secured by means of these bulkheads, by pumping more or less water from one end of the Dock than from the other, while the Dock is being raised or lowered. No use is made of them generally after it is pumped out. There are openings at the bottoms of the bulkheads, furnished with gates or valves for the passage of water to and from the pump-well. All the valves that open outside to admit water into the Dock, are of composition; those for the passage of water through the bulkheads to the pump-well, are of mahogany. There are eight windows through the upper chambers, twelve feet above the under side of the dock bottom. The plank on the bottom of the windows is six inches, fastened with three-fourths-inch iron bolts to beams eight by twelve, tenoned into the outside ribs, and into the stanchions of the upper chamber, and fastened with inch iron screw-bolts. The tops of the windows are planked with four-inch plank, fastened on to six by eight beams, tenoned into outside ribs and stanchions of the upper chamber. The sides are planked with the same thickness, and fastened with nine-inch spikes.

Deck of Chambers.

The tops of the chambers are decked over with three-inch plank, the deck beams being five-eighths scantling, halved together and laid so as to cross diagonally, forming lattice bracing. The deck beams are fastened with three-fourths-inch bolts, and the deck with eight-inch iron spikes.

APPENDIX.

Planking of the Dock.

The outside ribs are planked up above the thick-work, with four-inch plank, and fastened with one and and a quarter treenails through each rib; the treenails are caulked on the outside. There are three thick strakes, twelve by twelve, running the whole length of the Dock, one at the bottom and one at the top of the windows, and one along the upper ends of the ribs, fastened with seven-eighths-inch iron screw-bolts through the ribs, one in each rib; every butt in the planking has two three-fourths copper bolts as far up as twelve feet from the bottom of the Dock, to which height the whole is coppered with thirty-two ounce copper as before. Above that height the butt-bolts are of iron.

The insides of the upper chambers are planked with four-inch plank, and fastened in the same manner as above.

The ends of the chambers are planked up with six-inch plank, and fastened with treenails, the same on the sides, copper butt-bolted up to twelve feet. The sloping ribs are planked up with six-inch plank, alternately with a strake of twelve by twelve timber, of such form as to afford a step or altar to place the heels of the shores upon. This planking, and the thick strake, are fastened with one and a quarter treenails, passing through the ribs, and seven-eighths butt-bolts, two treenails in each sloping rib; in the planking the thick strakes have one seven-eighths iron bolt, and one treenail in each rib. All the planking above the thick-work are caulked with new oakum, in the ordinary way of caulking new ships of the largest class. The platform for the workmen to stand upon is of two and a half inch plank, laid on the fore-and-aft beams. The platform is fastened down with five-inch spikes.

The Dock is furnished with a floating gate. As it may be necessary to shorten the Dock with such a gate, when a ship of the line with all her armament on board is to be taken up, it is placed forward of the ship in grooves across the bottom and up the sides of the chambers. It is eight feet deep from the keel to the deck, and of the same form and proportions as that described for the basin. The fastenings for this gate are of iron.

The Dock, ready for use, weighs about five thousand tons nett of two thousand pounds.

Gates.

There is a gate at each end of the Dock, made of wood, and so arranged as to open and shut on a hinge extending across the entire length of the gate. The bottom timber of the gate is eighteen by twenty-four inches, the lower edge is half round, with the ends entirely rounded so as to pass through a bitt two feet on its face. The sill-piece upon which the gate rests is eighteen by eighteen inches, the upper edge being hollowed so as to receive the bottom timber of the gate; both this sill-piece and the bitts are fastened to the end of the Dock by one-inch copper screw-bolts, eleven bolts in each bitt, and three feet apart in the

sill-piece. The frame of the gate is made of stanchions, eight by twelve, placed fifteen inches apart, reaching up to a line with the lower line of the side windows, twenty-two feet above the bottom of the Dock. The ends of the gates are on an angle of forty-five degrees, the end-pieces eighteen by twenty-four inches; the stanchions are mortised into the lower piece of the gate, and into the slanting end-pieces, the tenons being eight by eight square, and each fastened with copper clinched bolts of seven-eighths-inch. The frame is supported by two trusses, one at the top and one at midway down. Each truss is supported by five iron key-bands, five inches wide, and three-fourths-inch thick, passing round the cord and arch of the truss; the ends of the arches and cords are screw-bolted together with three iron bolts, one inch thick. The trusses are supported in their horizontal position by iron braces one and a half inch thick. The gates are planked up with four by twelve plank, and fastened as far up as twelve feet from the bottom of the Dock with nine-inch composition spikes, two through each plank in every rib, and above with iron spikes, the like number of spikes in each rib. The gate at the forward end of the ship is made to unship by means of a sloat in the bitt.

There are two wicket gates in each, eighteen inches square. The timber which forms the frames of the end of the Dock, against which the gates close, is two feet square; the corner posts are rabbeted to receive the end planking of the Dock. The slanting post is also two feet square; it is tenoned into the post, the tenon being eight by eight inches, and reaching in six inches; this post extends down to the truss-beam, half of its thickness being cut away, leaving a shoulder of one foot resting on the top of the thick-work, to which it is fastened with one and three-eighths inch treenails, two through each thick strake, and one-inch copper bolt is also driven in through each thick strake, two feet long, as it passes down to the truss-beam below. The corners are fastened by oak knees, side twelve inches, twelve inches on the face at the ends, and twenty through the throat, each arm being five and a half feet long, and bolted with one and one-eighth iron bolts, twelve in each knee, reaching into the posts and thick-work twenty-two inches. The thick-work is dovetailed at the corners of the Dock, and each dovetail has a one-inch copper bolt reaching through the post and clinched.

APPENDIX.

NOTE I.

Engines, Pumps, and other Fixtures.

THE Engines, one on each side, are horizontal, and of twenty-horse power, and placed on the guards.

The Boiler is of the locomotive kind, and placed at one end of the engine, with the furnace on one side. The Pumps, twenty in number on each side, are made of plank five inches thick, and fastened with inch-iron screw-bolts, passing through and through all the parts; they are ten feet long with two feet square chambers, and three feet stroke; sixteen of the pumps are placed in the main pump-well, directly under the engine, and two of them are placed in smaller wells, adjoining the main well.

The upper and lower boxes are of composition; the lower one is made to fit the chamber by cork, placed in a groove, and the upper one is leathered, a ring screwing down upon it. The valves are of the kind called "butterfly valves," and also of composition. The guide rod is of iron, and the connecting is also of iron.

The pumps are driven by gearing and shafting, the shaft running the whole length; the pumps are thrown in and out of gear by clutches. At the end of the shaft is a windlass, by which the gates at each end of the Dock are opened. The chains by which the gates are opened are five-eighths. The forward gate is hoisted perpendicularly out of the bitts by means of the chain and windlass, and then lowered down into the water when a vessel is to be hoisted out of the Dock, and again hoisted in its place when the Dock is sunk to float the vessel. The pumps are so arranged as to pump out the Dock in raising a vessel with one engine, by means of a conductor.

The engines, boilers, and machinery attached to them, are inclosed with good houses, extending out to the guard. The combings are six by twelve deep, and the stanchions four by six scantling, placed two feet apart, the car lines four by four, and the plank of the sides and top is one and a half white pine. The guard is of timber twelve by twelve, and the beams of the guard-deck are six by twelve, and the braces underneath the guards are also six by twelve, the deck of guard three inches. The beams of the guard-deck are tenoned into the thick strakes of the Dock, and into the guard—the tenon being four inches, and fastened with one and a quarter treenails. The braces are tenoned into the second thick strake, and also bolted through into the ribs of the Dock. There is a rail on each side of the Dock five feet high. The whole surface of the Dock, inside and out, above the lower parts of the windows, is planed, and painted with two coats of lead color. The Dock is furnished with centering beams. It is also furnished with solid bilge blocks. The wall-shoring against the altars is furnished in accordance with the plans of the stone docks at Boston or Norfolk. All the gates, or valves, for the passage of water, are geared, so that one man can open or close them. This description also applies to the engines, pumps, and fixtures of the Pensacola Dock.

NOTE J.

Specifications for Basin and Gate.

THE stone basin is one hundred and twenty feet wide, and three hundred and sixty-five feet long, having, on three sides, walls of granite masonry thirteen feet high, six feet thick at bottom, and three at top, battering three feet in the whole height. The walls are built up to low-water mark, with split granite; above that height, with granite well cut.

The depth of water in this basin at high water is ten feet over the projecting courses of the stone on which the Dock rests. The foundation of the basin is formed of round twelve-inch piles, driven four feet apart, and capped with twelve by twelve timber, and five-inch yellow-pine plank secured to them in the firmest manner. There are double this number of piles under the courses of granite projections.

The platform is caulked with wedges of soft wood, four courses of hewn granite, twelve by twelve, is laid in cement upon the platform along the middle of the basin in the direction of its length. Two other courses, twelve by eighteen wide, are laid in the same direction, on each side, twenty feet from the central courses, forming level projections, or granite stringers, on which rests the Dock. The spaces between the courses of granite and the spaces out to the side-walls are filled with concrete six inches deep. There are three courses of stone across the bottom, at the outer end of the basin; the inner course is twelve inches thick, and forms a shoulder for the gate to bear against. The two outer courses are six inches thick; all these courses are fastened with seven-eighths copper bolts, two in each stone, driven down into the timber below. There is a groove in the outer end of the side-walls of the basin, two feet broad and one foot deep, to receive the boat gate.

The basin is inclosed with a boat gate. Its depth from the under side of the keel is thirteen feet, its breadth on deck twelve feet, and its length one hundred and twenty-eight feet; reaching across the mouth of the basin, its ends fitting into the grooves in the side walls of the basin; the keel is two feet broad by sixteen inches deep; the ends or stem pieces are two feet square, with an apron to back them, eighteen by eighteen inches; the keelson is two feet broad and eighteen inches deep; the ribs are twelve inches deep and eight inches broad, placed two feet apart and jogged into the keelson. It is planked up with four by twelve plank, the upper course or gunwale is twelve by twenty-four deep, and in connection with the deck beams forms the deck frame. The ribs are fastened at their upper ends to the gunwale, by inch iron screw-bolts.

The deck beams are eight inches wide and ten inches deep; they are placed four feet apart from centres, and cross diagonally; one set of beams cross another, halved where they cross, the ends being let down flush into the thick gunwale; the deck plank is three inches by twelve. Half-way between the deck beams and the keel there are beams across, of eight by eight scantling, resting on clamps running the whole length. There is a wicket gate of two feet square, so arranged that one man can open and close it. The boat is treenailed and copper fastened as fully as the best merchant vessels of like tonnage. It is coppered with twenty-four ounce copper up to eleven feet, and has all the necessary machinery and rigging for its use.

APPENDIX.

Note K.

Experiments on Bearing Piles of Basin.

There were eight different experiments performed upon seven piles that had been driven for the foundations of the basin at the Pensacola Navy Yard, by the order of the Department, by first applying ten tons, or more, to each of the seven piles, and then applying a sufficient power to one of the same, to withdraw it from the sand.

The first pile tested, had been driven six days; the others, two months previous. These piles were selected from the foundation piles, which had been driven prior to the time of the experiments, as being an average of the lot, both with regard to size and depth in sand. The nearest pile to them were other foundation piles, four feet distant. The depth of excavation of sand, taken at the average of the tops of the seven piles, was eleven feet five inches below ordinary high water; to which level, the cap timbers are placed. The piles were all yellow-pine, thirty feet long before driving, and average thirteen inches diameter at the middle of their lengths, round and bark on. Length of square point, from two to two and a half feet. Every pile banded with a hoop of best bar-iron, three by one inch, and driven in all cases without a follower. Average depth of piles in compact sand, fifteen feet. Average number of blows given each pile with a four thousand and eighty-seven pound hammer, sixty-nine; with a four thousand four hundred and seventy-eight pound hammer, sixty-four; and all the blows given at the rate of two and a half per minute. Theoretically the amount of force required to drive each pile is equal to five thousand five hundred tons. The average length of leaders used in piling machines was sixty feet.

The more time occupied in driving a pile the greater the number of blows required. In the experiments made to ascertain the comparative settlement of piles, note should be made of the time which passes between the successive blows of the hammer. The results of a few experiments upon the piles driven for that basin, showed that piles which settled six-tenths of an inch per blow of a four thousand and eighty-seven pound hammer, falling ten feet one day, were found to settle one-eighth, one-half, and six-tenths of an inch, by three *similar* and *successive* blows, applied the *following* day; the three blows being given in *one minute.* The nature of the sand at that yard, is such, that if allowed to remain undisturbed about the pile a short time, the power required to move the pile in any direction is very much increased.

The first experiment was tried on the 17th of May, 1851, when a power of twenty-three thousand eight hundred and fifty pounds was applied to one pile five minutes without moving the pile. In this experiment, a lever of the first order was employed, one foundation pile forming the fulcrum, and a large pile hammer placed on the long arm of the lever producing the power.

On the 20th of the same month, the second experiment was made, by applying a power of twenty thousand pounds to another pile, with a lever of the second order, with a steelyard to weigh the power at the long arm of the lever.

On the 21st, the third pile was subjected to the same strain for five minutes.

On the 22d, the fourth pile resisted the same power five minutes. There was then applied to this pile, fourteen tons for several minutes. Three other piles were subsequently tried, and resisted each ten tons power for five minutes.

On the 23d of May, the experiment of pulling of the piles was commenced, beginning with ten tons, (applied to pile number four, as above noted,) and increasing the power one ton every two minutes, i. e., after ten tons had been applied for twc minutes, eleven tons was applied for two minutes, then twelve tons, and so on, until fifteen tons power had been tried, when a hook of the steelyards broke. The 26th of same month, the experiment was resumed, after improving the apparatus for increasing the power, beginning with ten tons again, and gradually adding ton by ton, until there was thirty-one and a half tons, upward strain, acting against the pile. That experiment lasted one hour and forty minutes, during which time the power upon the pile was constant. There was afterwards a gradual increase of power to thirty-nine tons, without moving the pile; it then resisted forty tons for half a minute, when it began to rise very slowly; forty-one tons was then applied for one and two-thirds minutes; then forty-one and a half tons, for half a minute, the pile meanwhile moving upwards at the rate of one-twelfth of an inch per minute. The experiment of applying forty, forty-one, and forty-one and a half tons, occupied half an hour, during which, the strain being constant, the pile was moved two and a half inches. It was then subjected to a strain of thirty tons for eighteen hours, and was not moved by it; after which, by adding from thirty-two to thirty-seven tons, the pile was moved in one hour, three inches; and after it had been moved upwards about six inches, a power of twenty-five tons was allowed to remain on it for two days, and did not move it. This pile was afterwards entirely withdrawn from the sand. Its extreme length was twenty-nine feet, length of the part which had been in sand sixteen feet, including the sharpening point two feet long. One foot in depth about this pile was *loose* sand, which had been once excavated and fallen back. The average diameter of the part in sand, thirteen and a half inches, including the bark. The bark remained on the entire pile, except on three and a half feet of its pointed end, and was smoother apparently by the friction of the sand. There was no sand adhering to the pile except on the sides of the point, where there was a little sand apparently mixed with the turpentine or pitch of the yellow-pine stick. The pile weighed one thousand six hundred and thirty-two pounds.

The engineer (Mr. Dow) estimates, that this pile would have resisted a greater strain than forty tons, had it been applied more steadily, and without jarring the lever, and had all the work on the basin been stopped at the time; as the blows of the piling hammers *jar* the crust of the earth about the basin foundations for several hundred feet around.

A single foundation pile, used as a fulcrum for the lever, sustained at the most during the experiment, thirty-eight and ninety-six hundredths tons weight without settlement. This established a fact incidentally, although it is much less than what one pile is capable of sustaining.

The weight of water of Pensacola Bay, weighed at six different times, averaged sixty-three pounds per cubic foot. The water in the basin is *fresh.*

APPENDIX.

All these experiments were witnessed by James Herron, Engineer of the Yard and Superintendent of the Basin, and six of them, including the final pulling of one pile, by Captain John T. Newton, Commandant of the Pensacola Navy Yard. The result being considered satisfactory, the work of constructing the foundations of the Basin was resumed upon the original plan, and has been completed according to the contract and specifications.

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